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REMARKS ON PROFESSIONS IN MEDICINE[1]

By Dr. ALFRED E. COHN

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THIS invitation of yours to speak here to-night I regard as no ordinary honor. Once before you offered me this same opportunity. Ten years ago seems so far behind us as to have occurred almost in another life time. Some of you must remember that through a long hour you were patient. And now you ask me again. You give me the chance of feeling a deep satisfaction in the belief that I was tried and was not found wanting. We both take a great risk. I take mine willingly. For there are things as to which I believe I shall feel the better for having shared my thoughts. Nor can I think of men and women with whom I prefer to share them better than with you. We have, as it were, through long personal friendships, established common points of view which, on such occasions as this, come to some sort of systematic expression.

But I can not begin without recalling that I was brought here originally by Jack Wyckoff, whom I have always cherished as one of the most gifted of my friends. His gifts were not the gifts of tinsel—he did not shine by any of the arts that compel the immediate and spontaneous admiration of other men. Quite otherwise. His virtues came to be impressed upon us by their sheer weight—massive things which, because they were exercised in right directions, came to be understood to be expressions of deep intelligence and actuated by profound human sympathy. Wyckoff understood, I think, that the profession of medicine is so inextricably embedded in the social forces of our, indeed of any, time that it is a distortion of the facts to think of its position as something isolated. To

[1] Read before the Alpha Omega Alpha (Honorary Fraternity), Delta Chapter of New York, January 24, 1940.

him the life of a physician was not circumscribed by the content of his immediate profession but transcended such narrowing confines. Had he been spared so he could develop the bases of his beliefs, I feel reasonably confident the remarks I am about to make would have expressed his own views. I have as you see, an abiding faith in the possibility of his indefinite growth.

I believe in two things—one, that socially and intellectually we are the inheritors of our past and bound by it and, second, that it is possible for farseeing and determined men powerfully to change our direction and to influence our future—the future of our kind. We must be mindful though that the sum total of human experience has been small. Small as it is, it has been won at the expense of incredible suffering and toil. We may, as human beings, represent little in a cosmic sense. But toil and suffering are not things we care, or should care, lightly to bestow on our descendants, unless we choose to be utterly cynical. Our other path is to become conscious, by meticulous exploration of our past, of what its meaning has been and to try to discern whether that experience points a desirable way hereafter.

We know that in our dark and not so very ancient history, white men in civilized communities became, chiefly as prisoners of war, literally slaves. That was a practise of man's inhumanity to man which, as far as expression of belief is concerned and the hope of amelioration, came to an end with the Christian revolution 2,000 years ago. Belief and expression, though, are one thing, and the practise of life another. The extent to which actual human bondage is still practised and the variety of forms which the dominance of man by other men still assumes, it would surprise us, I think, if we passed in review: the social forms in the Far East and in the somewhat Nearer; the industrial forms almost everywhere; the political forms which, due to doctrinal disguise, are operative in so many regions. Even of actual individual human slavery, the world is far from being free. Feeling for the sufferings of other human beings—compassion, the good-will which rejoices because other men have been given the opportunity to realize their highest potentialities, the best that is in them, that pervading sense of the worth and the dignity and the potential decency of men, that which makes us speak of the value of the individual man—these are the basis of the entire theory of our profession. It is because we have beliefs that we are a profession. For I take it that profession means belief—belief that a form of life can be devised as the result of which there is rendered to other men, service. And service may involve sacrifice—sacrifice, disinterested indeed to the point where life, even if not always cheerfully lost, is at least dedicated to achieving a greater measure of welfare for common men less favorably situated, or less favorably endowed. If you run through your minds the names of the professions, my meaning becomes clear—medicine, law, the military, theology, engineering. You wonder perhaps at the inclusion of certain ones because you notice that there have slipped in as professions, ways of life from which, in the general belief, sacrifice is or has been departing and the notion and the object of gain or of profit has entered.

But let me not take you too far afield. Let me continue to insist that at the basis of a profession is concern for the welfare of individual men—their worth, their dignity, their suffering, their opportunity. It is to that concern I wish to attach the word "compassion." As I think, the watershed of all human thought, of all human organization, of all human aspiration, is this divide. There can be only two ways —concern for individual men or the subordination of individual men to interests which transcend their personal welfare. How our world is divided in its views on this issue requires no emphasis on my part. But here, in conception, lies a parting of the ways of which we can not pretend to be oblivious. For the profession of medicine it is crucial.

There is a second strain in the life of medicine, often, perhaps usually, regarded as its dominant strain —the intellectual strain. Systems or methods or the content of education are the reflections, sometimes very pale, of contemporary knowledge. For many and complicated reasons, that knowledge is not always conveyed in its essence—it is misunderstood or it is misrepresented. A minimum, the part that is palatable, comes out unscathed. Sometimes the accumulations of the past seem to be regarded as of little account. That must be because teachers prefer, not always wisely, to devote themselves to values believed to possess greater validity because they possess greater currency to-day.

But ideas have long lives. One of our great contemporaries believes, indeed, that being once born they march down through the ages having histories of their own. It is an engaging view. The point is not so much that questions which nature suggests to us to ask remain unchanging in their formulation as that a way of looking at nature once suggested keeps being insistent, sometimes more, sometimes less, the intensity of the search for an answer varying with special and general circumstances. I remind you that the uses to which the heart and the blood and the blood vessels are put, engaged the attention of naturalists very early. They (the Naturalists) kept coming back century after century to an attempt at solution, always

thinking that an answer had been found, but never aware of the inaccuracy or the inadequacy of those answers. We think now that we have been making and are making great strides toward understanding. And we are. But let me remind you also that in a very real sense, we possess small likelihood of thinking of kinds of mechanisms except those which lie reasonably close to our hands. And yet, in connection with the circulation and its mechanics, the questions we can and do ask for which there is not even an approach to an answer are very startling. I am thinking, in the heart, of so essential a part of its mechanism as rhythm—rhythm itself being a phenomenon widely recognized as occurring in many aspects of nature, without in most situations our having the remotest notion as to how to proceed to find an answer to our inquiry concerning its origin or its nature.

I may be permitted to keep looking for illustrations for my thesis in the domain of the heart. Beside rhythm, of equal importance, is contraction. With the unfolding nowadays of precise knowledge on how a substance, expressed in its chemical formula, is translated into another one through direct action or through the intermediation of enzymes and of other substances, whether proteins or not, the way ahead seems long before, with any assurance, we can predict a time or a situation, about which one can say, this is the end of our journey. And in this same domain of contraction, though surprising increases in knowledge have occurred since Hill and Meyerhof studied in its simpler phases the glycogen-lactic acid cycle, the gap between that mechanism and the behavior of the protein, myosin, to name the chief constituent of muscle, is wholly untouched. And yet we are entitled to believe that, compared with what Aristotle knew or Galen, or Vesalius, or Fabricius, or Harvey, or Lavoisier, or even Tigerstedt or Starling, the difference appears to be that between poverty and wealth. There is an important sense though in which that difference can be exaggerated. Aside from the accumulation of actual information, what should concern us is the cerebral power, that power of mastery in the face of mystery which the mind of man knows how to exhibit in unravelling the intricacies of nature. It makes no difference to us whether what they accomplished, now seems simple. That will be what our descendants are like to think of us. The form in which criticism is practised in the East is relevant here. There it is the function of critics to put themselves in the place of creative artists or indeed of creative scientists. There is, I think, no fundamental difference between the two. That function is *Einfühling,* a quality which makes it possible to feel into the original creative situation. If we compass this act there is little doubt we shall appreciate that the intellectual capability exhibited then was of an order similar to any shown nowadays. Discoveries and the content of discoveries are new. But the flights of which the imagination is capable—are they higher now than then?

We are wont to think that the intellect, like the wind, bloweth where it listeth. Even if this were true I doubt whether I, or whether anyone, could trace under what influences and in what environments, men have come to think what they did in building the content of our culture. Of the two main schools of opinion, that the mind has been free roaming in search of its interests and that it has moved within frameworks dictated by the needs and temper of a time, there is still no final decision. Most of us believe that we are, even if we have not always been, free agents; that what we do to succeed is exactly adapted to what we should do. We take the general view that these are matters which have been thought out and can therefore be dismissed because they have passed successfully through the fiery furnace of experience.

But let us pause a moment. Let us pass by the Greek thinkers, though even in their schools there was sharp discussion of what, in the way of doctrine, should and should not be taught, and pause when we come to those first centuries of this era when other worldliness drove out all interest in the concerns of this world. Something, it now seems certain, remains of the old interests in the west of Europe, but, it seems, not much—legacies but not practise. And these legacies were best preserved in the outskirts of the Mediterranean, not at its center—in Arabia, in North Africa, in Spain. Not until there was need for codifying and teaching the Cannon Law did the semblance of systematic instruction return to Europe. The mind was not free to roam, not in the case of Copernicus, nor Galilei, nor Vesalius, though it roamed delightedly in the realms that were attempting to make order in the conceptual world—concerning God, destiny and salvation. Later, by not more than three centuries, with a new orientation, inquiry about the real world began again. But it took less than another 100 years from the publication of "De humani corporis fabrica" (1543) to that of "De motu cordis" (1628) before teaching had become so crystallized in the universities that academies were founded in Italy, England, France and Germany to struggle with the problem of how to get on with the advancement of natural knowledge. Evidences of such struggles are to be found in many places, dealing with many subjects.

Nor did medicine escape. It is necessary to recall that although there was systematic instruction in medical subjects, more especially anatomy and anatomy

perhaps alone, beginning with the closing centuries of the Middle Ages, studying diseases and observing therapeutic successes did not begin until the sixteenth century. In the University of Paris, teaching Harvey's discovery that the blood circulates, was out of the question. To escape from dictation by the vested interests, the more active enquirers founded and were aided in founding by the Government, the Collège de France and the Académie des Sciences. In England in the sixteenth century knowledge was so sedimented and crystallized in Gresham College, that a forward movement, though having its forward impulse and seat there, came to be more hospitably received at Oxford in the so-called "Invisible College," later to be competently protected under the charter of the Royal Society. But it was medical subjects rather than medicine or medical disciplines in the form of a curriculum leading to a degree and the right, in any modern sense, to practice that came into existence. At the end of the eighteenth century at Speyer, Johann Peter Frank, a layman, a Minister of State, faced problems having to do with the public health without benefit of medicine. But it was in the eighteenth century that what we now recognize as the semblance of a curriculum began to appear.

What I am trying to emphasize in this random recital is that old as is the enquiry concerning the behavior of the body, both in health and in disease, interest in learning the nature of its processes without older prejudices, coupled with an interest in anything like a systematic form of teaching, are the inventions of very recent years. You will, I think, look in vain for periods in which there existed belief in complete *freedom* of inquiry, even when there was an inquiry at all. It is a mistake to think that the tradition of free inquiry is ancient, or so well established, that it can be taken for granted as one of the secure possessions of our society.

The contention then is that the curriculum, as an expression of belief, is reasonably recent; that the curriculum once accepted, itself has tended to undergo a succession of crystallizations; that each one of these crystallizations has tended to become a rock-like deposit so that force was required on more than one occasion to blast a way clear to permit newer ideas again to flow. And my moral is that, in this background, it is of the utmost importance to be on guard against perceived and of course unperceived repetitions of these catastrophes. You will not need to be convinced that my account of the situation at somewhat older periods is reasonably fair. But you will not be content with the inference that we need to-day to be vigilant unless I offer examples for my statements. I am speaking, you remember, of the intellectual strain in medicine, its viscissitudes, its checkered fate. Perhaps the most striking example that occurs to me is in the domain of medical psychology. Thirty years ago, in any ordinary sense, such studies were not so much ignored as not even considered. The mind of man had a place in nature, but not in the medical curriculum—except it be what was roughly called insane. The mind anyway, as has recently been so plentifully emphasized, though it is an important instrument in our existence, found little favor in the attention of serious students because, so far as could be told, it dealt with what Descartes termed secondary and not primary qualities. Then came an era, under the leadership of Charcot and Breuer and Freud in which an attempt to be serious about behavior was attempted. Since Freud's death it has been possible for Burt to say in *Nature:*

> Freud was, indeed, one of the boldest and most original of thinkers. Nevertheless, the isolated items in his theories were by no means so novel as is popularly supposed. Both in Great Britain and in America a strong reaction against the intellectualistic psychologies of the nineteenth century had already set in. James and Stout had emphasized the need for a more dynamic psychology; McDougall had urged the importance of unconscious motives, particularly in the instinctive and emotional life; Janet had emphasized the importance of dissociation in mental disorder and disease; Havelock Ellis had attempted a scientific study both of dreams and sex. Freud's own great achievement was perhaps to incorporate what was most fruitful in these ideas in a single, striking, unifying system, and to collect a vast amount of empirical data from a wide variety of sources, all illustrating much the same fundamental mechanisms of the mind.

But Freud was given no place in the University of Vienna either to study or to teach. His examination of the problems with which he dealt was not undertaken in any university in England; and in this country, although Hall was sufficiently concerned with this issue at Clark University to invite Freud to come there, there is still, so far as I know, no place in any university, except at Harvard University and there, not in the medical school but in the Department of Psychology, where these studies are welcome.[2]

I wish I were competent to search out and to set before you the reasons for this exclusion. If I venture to do so at all it is with the utmost trepidation and for no other reason than to find a gross example for a thesis I want in a moment to examine. It is not as if what I am about to say is invention of my own—in years past I have on many occasions taken part in and listened to conversations in which I learned

[2] I have recently been told that psychiatrists who have been psychoanalyzed are teaching in the University of Chicago. And the same statement may be warranted of other institutions. But that is not quite the same as having made an open provision for this form of teaching in medical schools.

that these were the views of many other men. To our great credit, be it said, it is well recognized that aberrant behaviors are among the commonest of the causes that send patients to physicians. That physicians are inadequately prepared to cope with such situations is recognized everywhere and the fact deeply deplored. But—to do anything to relieve this situation presents great difficulties. Our methods are not applicable to the analysis of these maladies. Is it unfair to point out that science is *only* a way of thinking about nature and that there was science before kymographs, manometers, galvanometers and Roentgen rays—perhaps even before weights and measures? These are the methods it is now respectable to employ. Until other appropriate ones become acceptable, it is not the part of respectability to meddle with them.

But if you regard this situation in medical psychology as exaggeration, let me recall that all advance with the aid of the intricate apparatus of laboratories was regarded as taboo by leaders of our profession no less recently than a single generation ago. Meetings and space in journals were devoted to disquisitions on the perils to which medicine was about to be exposed by men willing to devote all their time to current methods in the study of diseases. The echoes of that controversy are not yet dead, but times have materially changed, and quickly—it has now become respectable to attempt analytical methods. Let me recall further that our system was lacking in that there existed nothing essential except the professors, for whom the enterprise was on the whole chiefly a profit-making business. Obtaining a degree was a matter of having paid a fee. The course had no fixed length nor was it graded. Grading began in 1859 in the medical department of Northwestern University in Chicago—a three-year graded course. At Harvard College grading began in the early 1870's. And in a serious way it began at the Johns Hopkins in 1893 when the bachelor's degree was required for admission. There were no laboratories until 1878 when Dr. Delafield established one (The Laboratory of the Alumni Association at the College of Physicians and Surgeons) and until in the same year Dr. Welch opened a pathological laboratory, with private funds, I believe, at the Bellevue Hospital Medical College.

I want next to examine one aspect of the state of research in medicine and to draw lessons from the past to suggest that a forward advance is conceivably hindered by our current arrangements. It is not at all an infrequent experience in our hospital at the Rockefeller Institute that men come applying for posts at 27 to 29 years of age. The assumption when they come is naturally that what they desire is to devote their energies to the advancement of learning—to research. But there are among the applicants also men who, it turns out, intend rather to teach than to investigate and others still who wish to enter private or public practise. Recently among them was a very engaging and intelligent man who had decided that teaching was to be his career. He wanted instruction in the varieties of cardiac diseases. He wished to see intimately cases illustrating the senescent, the infectious, the toxic forms. After a period spent in observing one variety he wanted, much as internes do, to move on to another service—from mine, for example, to Doctor Swift's. I explained the situation; if you came for a year or two and had embarked on an investigation, presumably of significance—the chances were that when your time is up, you would still be far from having completed the written report of your experiences—to say nothing of attempting to savor one complicated subject after another. He understood, this lad, very well, when the situation was made clear. He was disappointed though because, when he entered practise as he intended to do, he would not have seen as correctly as he should have done cases of this or that named disease. He came from one of the better schools. That lad seemed to me to be laboring under a tragic misconception. He did not see that to the extent principles exist in groups of diseases, the essential thing in any discipline is to understand those principles, the general rules—that knowing all about individual so-called diseases was to attempt to assume a burden greater than was at all necessary and intellectually very uneconomical. But he went even further and wondered, indeed I think he doubted, whether there were value to him as a teacher in knowing something of the methods of research. I infer that I made my points in vain, for he decided against our plan of training.

I find this experience important. The fact that it has become customary to carry on research in university clinics is evidence of the wide belief that this practise has advantage. And those advantages ought to be vividly appreciated. To make clear to anyone the nature of a current conception, especially on the part of teacher to student, it has seemed desirable that the story of the growth of that piece of knowledge should be told and retold in a lively fashion. The story so often suggests the origin, purpose and success of an adventure. Going actually through the mechanics of performing a research is as lively a way as any of becoming sensitive to the history of how knowledge grows. And a teacher I should think would be the more effective the more he knew such stories at first hand. But then this is all commonplace and well known. Every one does not become a good teacher, no matter how much he obeys the rules of the game. But anyone can become a better teacher if he knows

how knowledge has been acquired so that he can tell stories rather than present completed pictures. I had hoped that that lad would depart a wiser, even if a sadder man. But no; he was not persuaded.

Of course there is much to the making of teachers beside having acquaintance with the dynamics of research. Undoubtedly, aside from the immediate content in subject matter, how to teach has a technique. I can not be greatly in error in supposing that in preparation for teaching, the subjects which are included in the curriculum of a medical school, how to combine the various elements in each—content, technique and history—still requires thoughtful canvass. Otherwise I could not have had my recent experience.

To that other subject to which I referred briefly just now, I want also to direct attention. I am aware that I am about to tread on dangerous ground, that it is ground with which I am insufficiently familiar, that what I think, at least now, before you have set me right, is open to serious criticism. I am persuaded though that the subject is important and merits very careful study if the advancement of knowledge in the study of diseases is to be in a healthy situation. It is unnecessary to speak of preparation for investigations of problems in morphology or in physiology or in that aspect of morphology and physiology combined which is biological chemistry. These are subjects of wide and general interest which would be undertaken even if there were no diseases—subjects which healthy men would venture to study to enlarge their comprehension of this world. But the matter of studying diseases—that is where a perplexing difficulty compellingly presents itself. There are several ways of approaching its analysis—I shall attempt two. First, let me speak of the case of a determined student, man or woman, arrived at the age of 29, now confronted, perhaps not for the first time, with what next to do to become a responsible investigator. At the age of 29, he or she has done what the curriculum prescribed. There are in point of fact few persons who have the hardihood to ignore what is prescribed and I have recently learned again of the cases of men who were warned against making the attempt even of adopting bio-chemistry as a career except under the aegis of the medical curriculum and the medical school with the imprimatur of the degree of doctor of medicine. There is, of course, in this debate, a valuable argument in favor of knowing the background, as the curriculum presents it, of a discipline in which students design to carry on investigations. But need it be the whole, unmodified, time consuming and in part irrelevant curriculum? How much more hazardous would it be in point of fact for one intending to study diseases to proceed on an original course exactly and broadly calculated to fit him for his enterprise?

But it is desirable to turn aside to look at the medical curriculum. It is, is it not, a rigid structure, designed to acquaint students with what experienced persons regard as indispensable to those who engage in the practise of medicine. In part, the structure is responsive to a sort of historical blackmail exercised by Boards of Regents when they construct examinations for the license to practise. The Regents themselves are the victims of the historical process and system. And so history, the future, the Regents and the faculty combine to make the curriculum what it has become. So far as the fair, enticing, irrelevant world is concerned the curriculum is partly shafts and partly blinders. Do I exaggerate when I say it contains a great mass of necessary elements, no doubt, but from any single or many points of view, often ill assorted? Is it incorrect to believe that it contains subjects or parts of subjects which are taught because once they were regarded as relevant to current knowledge? The history of curriculums is the history of succeeding beliefs. We hold beliefs longer than we should and do not permit them to be dislodged when they *should* be, by novel discoveries and situations. We make our curriculums rigid so that revolutions are necessary to make room for new ideas. Conventions have such momentum that we teach them far beyond the time when they represent truth—to the exclusion of novelty. Novelty then grows up outside of schools and is later either forcibly admitted or becomes so potent as to exert disruptive force. I am not referring, as earlier, to the historical aspects of relevant subjects but to subjects which either need not be taught because they have no practical bearing or to subjects which, even if they have, receive a devotion in the time spent upon them out of all proportion to what is necessary, if there were introduced suitable latitude in the techniques of instruction. I am speaking of the mere saving of time. Of course I have been reminded that learning consists not only in becoming acquainted with subject matter but as much with the duration of familiarity with that subject, and that success is a function of the length of time we have the opportunity or the necessity of holding that subject matter in our consciousness. These are debatable matters. Indeed I am prepared to have you demonstrate to me that there is now in the curriculum nothing useless, that there is no misuse of time.

In that event we are at an impasse. Students, not many perhaps but a few and very important ones, have in good faith passed through our schools and their interne periods—the periods of their major impressionability. They are 27 to 29 years old and when they come to us they must be told that the time is all but passed for them to become professional investigators. Of all of this I have seen tragic consequences. It is the more tragic when you reflect that

in other disciplines, in other natural sciences, in physics, and in chemistry and in subjects such as mathematics, great discoveries have been made before this age of 27 to 29. But even if late, why has it become at least doubtful whether a medical school is so constituted as to be a good training ground for learning how to carry on research in diseases? What the situation is in the study of diseases is, of course, familiar to you. I pass over that compartmentalization of diseases which has made it merely conventional to separate infectious diseases from those exhibiting predominantly chemical or physiological aspects. But these are essential differences when the time comes to apply the techniques of analysis. When that time comes it is also familiar to you that the comprehension that issues from analysis is obtained now, as no doubt it always was, not at the level of organization at which diseases, or indeed any phenomenon exists, but at a level more general and more simple, less organized, less special, than the obvious and apparent aspect which the whole integrated action presents. And nowadays whether a disease is metabolic or immunological or physiological so-called, essential investigation begins to take place at a level not at all obvious. How hormones actually operate, how muscle contracts, how the body defends itself against attack from infectious agents is to understand that mechanism in terms which do not in the least disclose themselves to the immediate attention either of patients or physicians. Naturally it would be absurd to say that an end has come to the opportunity for therapy on irrational grounds. One need not have so great confidence in the operation of the mind as to suppose that only through its mediation are far-reaching discoveries to come about. Contrariwise though, rational therapeutics can not be supposed to be dependent upon the comprehension of the superficial processes actually encountered. But to investigate at those levels of organization in disturbed or diseased organisms at which malfunction occurs seems to suggest on the part of investigators the possession of technical competence which can be acquired apparently only through long familiarity with the thinking and the techniques which are requisite in elucidating the mechanisms which are actually in operation. At 29 it is too late for most men on the threshold of economic responsibility, even if it were possible intellectually, to undertake essential reorientations in order to acquire the necessary equipment. I speak with feeling. Perhaps men will always be speaking with similar feeling in the sense that similar surprises lurk in store for all of us—we live on into unfamiliar eras. We are not spared like Cato, knowledge of the greater Rome. And in these days we live very fast. I am, if you please, not to be misunderstood; there are multitudes of collateral sources of interest and opportunities for the display of intellectual energies. Whatever other situations exist, this one, on which rational analysis depends, begins seriously to be removed from the opportunity of men arrived at 27. The inescapable consequence of this situation is that if problems now recognized as capable of solution are to be solved, salvation must result from the activities of men trained not as physicians are trained now. Other men, whether chemists or physicists or physiologists must be drawn into the service. Physicians who have first acquaintance with the phenomena and meaning of diseases must step aside from careers of this sort of adventure and limit themselves to the care of the sick. This is a noble and engrossing enough calling. But the serious and unfortunate question remains—must physicians insist upon such self-denying ordinances, when the opportunities for a different arrangement of study have not adequately been explored? In that case physicians have trained themselves so as to become incapable of investigating, at an appropriate level, the very subjects of their deepest concern. The result is deplorable only if one thinks it so. Many do. Indeed there are many physicians who think that the recognition and understanding of such special phenomena as diseases are not likely to be studied as successfully by others as by those whose especial concern and responsibility they are. A compromise has often been effected through association of physicians with other scientists. That may be the necessary conclusion of the matter. And yet—there are men of 27 who desire a different solution.

What I have been saying earlier is that it may be possible, by taking thought, finally to add a cubit to our intellectual stature. We may be able to guide men who wish to find themselves in different positions at 27, into different channels—either in our schools or through flexible arrangements elsewhere in the universities. If suitable arrangements can be made within the schools, a signal advantage would be gained through the simultaneous presence under protection of men of similar ultimate interests, of varieties of students actuated by similar motives, devoted to similar ends and separated only by the different approaches to those ends. Ten years ago I entered a plea in this company for mutual understanding among all of us devoted to the service of different aspects of our lives in medicine. I am reverting to that subject. What I have observed in the interval is that the old Adam still struts among us, that all the differences in temperament have not been bridged. Men still fall into strata. They still practise their snobberies. It is a little soon to expect the heaven, we hope, all of us, to establish on our earth. But now when we begin to understand better what the elements of our problem

are, I ask seriously whether this situation should not be taken into review. Whether we can not find ways in which within the schools, means can not be found for educating men, within a faculty of the medical sciences, to undertake the variety of services which lie open to us. Men of 21 are perhaps not too young to declare, provided the facts have been placed before them, wherein their dominant interests lie. Life is too hard and competition too keen, much longer to permit ourselves the luxury of *not* knowing. You will say, the trouble lies farther back, in school and college—and I agree. We begin, all of us, to recognize the fact that the physical frontier has disappeared only to find that instead of being far away and out of reach, it has moved close to our very doors. There are new frontiers; we must choose, young and early, which one we are to cross and within which one we are to find home. We know anyway—most of us. We can be aided by discerning advisers. The various careers in medicine can then be harmoniously developed. Diseases can be competently studied. Their analysis need not be delayed or made complicated by requiring the collaboration, no matter how eager and willing, on the part of men of different outlooks and trainings and interests.

Whether the problem I present can be solved in the way I suggest makes little difference. I am more interested in raising doubt lest we be betrayed by our sense of security—doubt lest we conclude that what has once been adopted is eternally established. The history of intellectual organization, as this has been illustrated in the behavior of universities, I have suggested, does not necessarily encourage us to conclude that there is nothing left to suspect or to learn.

There is no other profession which requires of its members so great a range of responsibilities—the whole gamut of human concerns from irrational to rational. Response to suffering is the *fons et origo* of our motivation. The history of man has made us aware at least of this, exemplified in St. Francis, that sensitiveness to suffering is bred in our beings. We could not escape the motive of compassion if we would. But to be effective, we must, in this very necessity, collectively put hard heads at the service of soft hearts. There lies the difficulty of our complex professional existence. Somehow we must harmonize our dual nature. That may, hereafter, turn out to be more difficult than ever it has been. But the success of our test will be measured in the degree to which we recognize our double obligation and embrace our double opportunities.

SCIENTIFIC EVENTS

THE PRINTING PRESS OF LEONARDO DA VINCI

THERE was an informal private opening of an exhibition of the scientific achievements of Leonardo da Vinci at the New York Museum of Science and Industry on Wednesday, July 24.

Correspondents have called attention to a quotation in the issue of SCIENCE for May 24 in regard to the printing press of Leonardo, stating that it antedated the press of Gutenberg. This is obviously impossible, as Gutenberg died in 1468 and Leonardo was born in 1452. In regard to the press of Leonardo, SCIENCE has received from a correspondent the following details:

To ascribe a definite date and a definite locality to Leonardo's printing press would be quite impossible because of the lack of authoritative records. Suffice it to say that the machine was put into actual operation somewhere in Italy toward the end of the fifteenth century.

Leonardo's exhaustive mechanical studies and applications proved very helpful in enabling him to produce a machine much more practical than that of Gutenberg's, in that it could be operated by one man in a comparatively simple manner.

Movable type was cast of lead and placed in a shallow basin on a very heavy wooden car equipped with rollers. Once the type was in position the actual printing was a very simple matter, requiring but the turning of a solid wooden cylinder threaded at both ends, which turning caused several simultaneous things to happen. A large cogged wheel on the top of a very massive wooden frame engaged with cogs on the upper end of a long pipe, which rotated rapidly, causing the rope connected to the car to wind on a roller, thereby pulling the car into position under a heavy wooden block, which, lowered because of the turning, provided the pressure needed for the impression.

Turning the cylinder in the opposite direction raised the weight and let the car roll down a slightly inclined plane for the printer to place another sheet of paper over the type.

Because of Leonardo's studies on the effect of friction this machine is as frictionless as possible, and with a system of weights so arranged as to be perfectly balanced, the operation of this press is almost effortless.

To those who appreciate the beauty of simplicity and compactness in a mechanical contraption the beauty of this press is inescapable and the amazing versatility of the inventor startling in its scope.

A working model of this press is included in the present exhibition of the works of Leonardo. On this same model a short description of its invention and operation was printed during a similar exposition last year in Milan, Italy.

LABORATORY OF THE COMMISSION ON THE STANDARDIZATION OF BIOLOGICAL STAINS

THE Philadelphia College of Pharmacy and Science at Philadelphia has been selected as the new location for the laboratory of the Commission on the Standardization of Biological Stains. This laboratory, until recently at the Arlington Experimental Farm (Virginia) of the Bureau of Agricultural Chemistry and Engineering of the U. S. Department of Agriculture, is now working in the department of chemistry through the cooperation of Dr. Louis Gershenfeld, head of the department of bacteriology and hygiene, and Dr. Arthur Osol, director of the chemical laboratories.

Under the direction of Mrs. Anis P. Bradshaw, formerly of Arlington, the purpose of the laboratory is to carry out the chemical analyses necessary for the certification of dyestuffs to be employed as biological stains for bacteria identification and for diagnostic determinations in the United States and in certain Pan-American countries. All dyestuffs employed for biological determinations are tested for dye content and identity. Another important object of the work is the improvement in existing products and the synthesis of new dyes for specific purposes. In addition all certified bacteriological stains are checked as to their suitability in the staining technics in which they are to be used at the Agricultural Experiment Station at Geneva, N. Y. Both the chemical and bacteriological laboratories work in close cooperation and much of the work is verified through bacteriological experimentation by specialists. The establishment of the commission dates back to 1920, when dyestuffs which had been imported from Germany were no longer available. In general the American products at that time were not satisfactory. At the suggestion of the Society of American Bacteriologists and under the auspices of the National Research Council, the laboratory was established under a grant from the Chemical Foundation. During the past two decades the work of the commission has been expanded. It is under the chairmanship of Dr. H. J. Conn, of the New York State Agricultural Experimental Station at Geneva.

The Philadelphia College of Pharmacy and Science recently observed the one hundred and eighteenth commencement since its founding in 1821. At that exercise, Dr. Louis Gershenfeld, under whose auspices the laboratory came to Philadelphia, was awarded the honorary degree of doctor of science.

MEETING OF THE PAN-AMERICAN CONGRESS OF OPHTHALMOLOGY AT CLEVELAND

PLANS for a Pan-American Congress of Ophthalmology to be held at Cleveland on October 11 and 12 have been announced. The congress will be sponsored by the American Academy of Ophthalmology and Otolaryngology, an organization of more than 2,500 specialists in diseases of the eye, ear, nose and throat, which will hold its annual convention immediately preceding the Pan-American gathering.

The U. S. Department of State has expressed its interest, and the governments of all the countries of the Western Hemisphere have been invited to send official delegates. It is hoped that the meeting will do much toward bringing about an *entente cordiale* among scientific men of the two Americas, and it is expected that a permanent organization will be effected.

The committee that is developing the congress has the following members: Drs. Harry Gradle, Chicago; Conrad Berens, New York, and Moacyr E. Alvaro, São Paulo, Brazil. The executive secretary of the American Academy of Ophthalmology and Otolaryngology, which will be host to the Latin-American eye specialists, is Dr. William P. Wherry, 1500 Medical Arts Building, Omaha, Nebr.

Under the direction of Dr. Berens, papers in Spanish or Portuguese will be made understandable to English-speaking ophthalmologists by the use of lantern slides projecting a synopsis of each paragraph translated into English. The reverse process will be used with the English papers. Spanish and Portuguese stenographers will be present to record the discussions in the language of the authors.

The congress is open to any ophthalmologist who wishes to register. Non-members of the Academy of Ophthalmology and Otolaryngology may register regardless of attendance at the academy meeting proper. Individual invitations have been sent to about 1,800 members of the ophthalmologic profession in the Latin-American countries, as well as to the national societies of eye specialists and the universities. Individual invitations were not sent to ophthalmologists in the United States and Canada, but official invitations to them are being printed in the various journals of ophthalmology. A fee of $5 has been set for membership in the congress.

CONFERENCE ON APPLIED NUCLEAR PHYSICS

A GENERAL conference on Applied Nuclear Physics, sponsored by the American Institute of Physics in cooperation with the Massachusetts Institute of Technology, will be held during the week of October 28 to November 2, at the institute. The rapidly increasing number of applications of methods and apparatus characteristic of nuclear physics in the fields of biology, radiology, chemistry, geology and industrial physics has long emphasized the usefulness of a joint conference between physicists and their colleagues in other fields of science.

The purposes of the conference are to bring together

investigators who may be widely separated geographically, and to provide a forum for assembling and correlating present knowledge and difficulties, and for directing attention toward fundamental lines of research which should be the subject of future investigations.

The week's activities will be divided into separate sessions on applications to biology, chemistry, radiology, metallurgy, geology, and to general sessions relating to the production and use of radioactive and stable isotopes, and the protection of workers from radiation. The subjects to be discussed are:

October 28, Techniques and Standards in Terrestrial Radioactivity Measurements; Tracer Studies of Metal Diffusion and Corrosion; Geochemical Applications of Radioactivity; Radiography with Gamma-Rays, X-Rays and Neutrons.

October 29, Radioactive Methods of Geologic Age Determinations; Tracer Techniques in General Chemistry; General Aspects of Cancer Therapy; Geophysical Applications of Nuclear Physics; Tracer Techniques in Analytical Chemistry; Radium and Roentgen Therapy.

October 30, Production of Radioactive and Stable Isotopes and of Penetrating Radiations; Measurement of Radioactive and Stable Isotopes and of Penetrating Radiations.

October 31, Protection of Workers from Biological Effects of Radiation; Synthesis of Organic Substances Containing Tracers; Neutron and Artificial Radioactivity Therapy; Tracer Techniques in Biology.

November 1, Dosage Measurements; Tracer Studies of Plant and Animal Metabolism; Radiobiology; Tracer Studies (continued).

November 2, Tracer Studies (concluded); Contributed Papers.

The daily sessions will consist of short invited papers by leading investigators followed by discussion. Ample time will be allowed between and after regular sessions for personal and informal conferences. While the emphasis will be on the program of invited papers and the discussion of these, provision has also been made for a limited number of ten-minute contributed papers. Five one-hour evening sessions will be held, in each of which an outstanding investigator will summarize the status of the several fields which are joined together by the conference. The evening lectures will be open to the general public.

The committee in charge of the program includes Robley D. Evans, *chairman,* Massachusetts Institute of Technology; Elmer Hutchisson, *secretary,* University of Pittsburgh; Henry A. Barton, American Institute of Physics; Edw. U. Condon, Westinghouse Electric and Manufacturing Company; Lee A. DuBridge, University of Rochester; G. Failla, Memorial Hospital, New York; Clark Goodman, Massachusetts Institute of Technology; Ernest O. Lawrence, University of California; Harold C. Urey, Columbia University.

Letters and inquiries should be addressed to Professor Robley D. Evans, *general chairman,* Conference on Applied Nuclear Physics, Massachusetts Institute of Technology.

RETIRING MEMBERS OF THE FACULTY OF THE OHIO STATE UNIVERSITY

The Ohio State University Monthly reports that five members of the faculty of the Ohio State University retired at the close of the academic year with the title emeritus. They have served for periods ranging from twenty-six to forty-one years.

Those on whom the title was conferred are Dr. William E. Henderson, professor of chemistry; Dr. George Bolling, professor of classical languages; Dr. James E. Hagerty, professor of social administration; Dr. Edwin F. Coddington, professor of civil engineering, and Professor Alonzo Tuttle, of the College of Law.

In recognition of their services, the Board of Trustees adopted the following resolution:

Whereas, Five members of the Ohio State University faculty are retiring from active duty on September 1, 1940, with the well-merited rank of emeritus professors, and

Whereas, In their periods of university service ranging from twenty-six to forty-one years they have given unselfishly and devotedly of their time and energy in the classroom and in the laboratory, in important committee responsibilities, and in other areas of the institution's activities and relationships; now, therefore, be it

RESOLVED that this board express the gratitude and appreciation of the Ohio State University to the following five members of the faculty who are soon to relinquish the responsibilities of active membership on the staff.

The citations for Professor Henderson and Professor Coddington are given below:

DR. WILLIAM E. HENDERSON, professor of chemistry, who has distinguished himself in his professional field as a teacher and as an author; who has served since 1899 as a member of the faculty in the department of chemistry, with added responsibilities in the years 1921 to 1927 as dean of the College of Arts, Philosophy and Science, and more recently as a member of the faculty committee to advise with the Board of Trustees on university affairs.

DR. EDWIN F. CODDINGTON, professor of geodetic engineering; an alumnus of our own university who returned to the faculty of his alma mater in 1902 and has served it continuously and with devotion since that time, in the departments of mathematics, mechanics and civil engineering, as well as on the staff of the Engineering Experiment Station; for five years, 1915 to 1920, he was acting dean of the College of Engineering.

RECENT DEATHS

DR. SIGARD ADOLPHUS KNOPF, physician of New York City, formerly professor of phthisiotherapy at the New York Post-Graduate Medical School, died on July 15 at the age of eighty-two years.

PROFESSOR FRANK GEORGE WREN, Walker professor of mathematics, dean of the School of Arts and Sciences of Tufts College, died on July 17 at the age of sixty-six years.

DR. HARRY AUGUSTUS ITTER, professor of geology at Lafayette College, died on July 14 at the age of forty-one years.

DR. MATTHEW YOUNG, lecturer in anatomy at University College, London, died on May 25 at the age of fifty-six years.

THE death is announced at the age of ninety years of Dr. Edoardo Maragliano, Senator of Italy, who had been president of the medical faculty and rector of the University of Genoa, and for forty-three years professor of clinical medicine.

SCIENTIFIC NOTES AND NEWS

The Archives of Pathology for July is dedicated to Dr. S. Burt Wolbach, Shattuck professor of pathological anatomy in the Harvard Medical School, pathologist of the Peter Bent Brigham Hospital and of other Boston hospitals. Dr. Walter B. Cannon writes an introduction to this special issue, which contains research articles by many of Dr. Wolbach's present and former students and associates.

DR. PHILIP E. SMITH, professor of anatomy at the College of Physicians and Surgeons of Columbia University, was recently awarded the Charles Mickle Fellowship of the University of Toronto in recognition of his work on the pituitary gland. The fellow receives the annual income from an endowment fund of $25,000 provided under a bequest by the late Dr. W. J. Mickle. It is awarded annually "to that member of the medical profession who is considered by the council of the Faculty of Medicine of the University of Toronto to have done most during the preceding ten years to advance sound knowledge of a practical kind in medical art or science."

DR. D. C. WARREN, of the poultry department of the Kansas State College at Manhattan, was presented with the $1,000 Borden Award "for outstanding research work in poultry husbandry in the United States and Canada during the past seven years," at the thirty-second annual meeting of the Poultry Science Association, which was held last month at Cornell University.

DR. KARL B. MCEACHRON, director of the "Lightning Laboratory" of the General Electric Company in Schenectady, N. Y., received the award of the B. F. Goodrich Company "for distinguished public service" in special ceremonies at the World's Fair in commemoration of the hundred and eighty-fifth anniversary of Benjamin Franklin's kite experiment with lightning.

DR. WARREN H. LEWIS, who is retiring as research associate in the department of embryology of the Carnegie Institution of Washington and professor of physiological anatomy in the Johns Hopkins University, has been appointed a member of the Wistar Institute of Anatomy and Biology in Philadelphia, as of July the first. The Carnegie Institution is maintaining at the Wistar Institute the program of Mrs. Warren H. (Margaret A. R.) Lewis, research associate in the institution, on the same basis as in past years at the laboratories of the Carnegie Institution in Baltimore, and the International Cancer Research Foundation is continuing to assist the investigations of Dr. and Mrs. Lewis by a grant for research assistance as in past years.

DR. KARL K. DARROW, research physicist at the Bell Telephone Laboratories, has been appointed visiting professor of physics on the William Allan Neilson Foundation at Smith College for the second semester 1940–41. He will be the fifth scholar to occupy the chair, which was founded in 1927 as a gift to William Allan Neilson in recognition of his completion of ten years service as third president of Smith College. The foundation was permanently endowed by alumnae, undergraduates and friends of the college in June, 1935. Dr. Darrow will present a series of lectures in the field of atomic physics suitable for members of the department and for advanced students, seniors and graduate students of other departments. He will also contribute to a seminar in nuclear physics.

RECENT promotions at the College of Medicine of the State University of Iowa include the following: Dr. Erwin G. Gross, chairman of the department of pharmacology; Dr. Walter R. Ingram, professor and head of the department of anatomy, neuroanatomy, histology and embryology; Dr. Rubin Flocks, associate professor of urology, and Dr. Irving H. Borts, assistant professor of hygiene and preventive medicine.

DR. CARL C. PFEIFFER, formerly instructor in pharmacology at the University of Chicago, has been appointed associate professor of pharmacology at Wayne University Medical School.

THE REV. CHARLES A. BERGER, of the department of biology at Woodstock College, Md., has become head of the department of biology at Fordham University. Dr. George Antonoff, of the Universities of Manchester and Cambridge, has been appointed visiting professor of chemistry.

PROFESSOR N. H. MANDERFIELD, head of the department of metallurgy and mineral dressing of the Michigan College of Mining and Technology, Houghton, who has worked at the industrial applications of the subject and in mineral dressing curricula, has been made chairman of a newly established department of mineral dressing. Walter Keck has been promoted from an assistant to an associate professorship of mineral dressing.

DR. ARTHUR S. ADAMS, assistant to the president of the Colorado School of Mines, has been appointed assistant to the dean of the College of Engineering of Cornell University. He will be an addition to the present administrative staff of the college with functions in the general area of academic development.

ALLYN RYERSON JENNINGS, since 1936 general superintendent of the Department of Parks of New York City, was appointed general director of the New York Zoological Park and of the New York Aquarium at a meeting on July 15 of the board of trustees of the society. He succeeds Dr. W. Reid Blair, who retired on May 1, having reached the age of sixty-five years. He had been connected with the park for thirty-eight years, for fourteen years as director. Harry Sweeney, Jr., of the Park Department, who for the last two years has directed the New York City exhibit at the World's Fair, was appointed assistant general director. George E. Spargo, assistant park commissioner, will succeed Mr. Jennings as ranking officer of the Park Department.

JAMES STOKLEY, who had been a member of Science Service until 1931, when he accepted a position with the Franklin Institute, Philadelphia, later becoming director of the Buhl Planetarium, Pittsburgh, has rejoined the Service. He will take the place of Robert D. Potter, staff writer in the physical sciences, who resigned on June 1 to become science editor of the *American Weekly*.

JAMES H. CRITCHETT, vice-president of the Electro Metallurgical Company and of the Union Carbide and Carbon Research Laboratories, Inc., New York, past president of the American Electrochemical Society, has become a member of the Division of Chemistry and Chemical Technology of the National Research Council.

DR. CLARENCE ORION CHENEY, professor of clinical psychiatry at the Cornell University Medical College, has been appointed a member of the medical board of the New York Hospital.

DR. FRIEDRICH W. KLEMPERER, of the Harvard University Medical School, has been appointed editor of the section on Biochemical Techniques and Apparatus of *Biological Abstracts*, in succession to the late Dr. Glenn E. Cullen.

LINCOLN T. WORK, assistant professor of chemical engineering at Columbia University, has been appointed director of research and development of the Metal and Thermite Corporation, New York, N. Y.

DR. T. G. YUNCKER, professor of botany at DePauw University, has returned to the United States after a year's absence in the south seas under the auspices of Bishop Museum at Honolulu. Collections were made in the Manua group of the Samoan Islands and also on the island of Niue, which had not previously been visited by botanists.

DR. A. G. PLAKIDAS, associate plant pathologist at the Louisiana Agricultural Experiment Station, has a year's leave of absence, beginning on September 1, for special study at Cornell University under a grant from the General Education Board.

THE Norman Lockyer lecture of the British Association was given at Hull on June 24 by Professor W. L. Bragg.

A CONFERENCE on Science, Philosophy and Religion in their Relation to the Democratic Way of Life will be held at the Jewish Theological Seminary of America, New York City, on September 9, 10 and 11. Dr. Edwin G. Conklin, professor of biology emeritus at Princeton University, executive vice-president of the American Philosophical Society, will speak before the division of the Natural Sciences, and a paper by Dr. Albert Einstein, Institute for Advanced Study at Princeton, N. J., will be presented by title.

A COUNCIL of Scientific Societies of Western New York, composed of two representatives from each participating society or group, has been formed to stimulate and to form a central clearing house for scientific activities in the Niagara Frontier. It plans to bring together individual investigators and to encourage national societies to visit Buffalo; to act as adviser to the schools, museums, local groups and individuals; to encourage local scientific exhibitions and demonstrations; to further publication of research and to assemble and maintain a bibliography of scientific publications concerning the area or by residents of the area. Irving G. Reimann is president of the council, A. H. Bennett and Dr. Ellen M. Nicholson are vice-presidents; Miss Kathryn Alden Schenck is secretary, and Professor W. P. Alexander treasurer.

THE U. S. Civil Service Commission has announced examinations to fill engineering positions in the government in various specialized fields. Salaries range from $2,600 to $4,600 a year, less a retirement deduction of 3½ per cent. Applications should be filed with the Commission's Washington office not later than August 5. There are also announced examinations to secure explosives engineers for the Federal service.

The examination covers five grades, with salaries ranging from $2,600 to $5,600 a year, less the retirement deduction. Applications should be on file with the Commission's Washington office on August 19. Further information regarding these examinations may be obtained from the Secretary of the Board of U. S. Civil Service Examiners at any first- or second-class post office, or from the U. S. Civil Service Commission, Washington, D. C.

ALPHA EPSILON DELTA, the national honorary premedical fraternity, recently installed a new chapter at the Ohio State University. On May 31 Dr. Emmett B. Carmichael, of the School of Medicine of the University of Alabama, who is executive councilor of the fraternity, installed thirty students and four members of the faculty of the charter group as the Ohio Alpha Chapter. Members of the faculty initiated as honorary members of the fraternity were: Dr. H. E. Setterfield, associate professor of anatomy in the College of Medicine; Dr. Alva W. Smith, associate professor of physics; Dr. Raymond J. Seymour, professor of physiology in the College of Medicine, and Dr. Joseph N. Miller, instructor in parasitology.

THE Desert Laboratory at Tucson, Arizona, has been turned over by the Carnegie Institution of Washington, D. C., to the Forest Service. The Desert Laboratory was concerned with the study of arid and semi-arid regions which comprise almost a fourth of the area of continental United States.

A FELLOWSHIP has been established in the National Research Council for the year 1940–41 through funds provided by the RCA Manufacturing Company, Inc., for the purpose of investigating biological problems such as the structure of viruses, bacteria and other micro-organisms, and tissue cells with the electron microscope. It will carry a stipend of $3,000 and will be known as the RCA Fellowship, to be awarded by the following committee of the National Research Council, who will act also in an advisory capacity to the fellow: Stuart Mudd, *chairman*, M. Demerec, Caryl P. Haskins, J. H. Kempton, C. W. Metz, W. M. Stanley and V. K. Zworykin. The work will be carried on in the Research Laboratories of the RCA in Camden, N. J. In considering candidates, preference will be given to versatile young men of United States citizenship, who have sound training in micro-biology, a doctor's degree and a record of original work. Applications, in quadruplicate, on forms which will be supplied on request, together with supporting documents, should be submitted on or before August 15 to the Division of Biology and Agriculture, National Research Council, 2101 Constitution Avenue, Washington, D. C.

APPROPRIATIONS of the Federal Government to the various states for improvement of game conditions amount to the sum of $2,300,000. Michigan received the largest amount, $127,322; Texas was second with $120,297, and New York third with $120,163. Participating states are required to contribute 25 per cent. of the cost of any project. The total sum available in aid of wild life for the present year is $3,066,667.

DISCUSSION

THE NATURE OF THE INTERMOLECULAR FORCES OPERATIVE IN BIOLOGICAL PROCESSES

IN recent papers P. Jordan[1] has advanced the idea that there exists a quantum-mechanical stabilizing interaction, operating preferentially between identical or nearly identical molecules or parts of molecules, which is of great importance for biological processes; in particular, he has suggested that this interaction might be able to influence the process of biological molecular synthesis in such a way that replicas of molecules present in the cell are formed. He has used the idea in connection with suggested explanations of the reproduction of genes, the growth of bacteriophage, the formation of antibodies, and other biological phenomena. The novelty in Jordan's work lies in his suggestion that the well-known quantum-mechanical resonance phenomenon would lead to attraction between molecules containing identical groups and to autocatalytic reproduction of molecules. Jordan himself expressed some doubt as to whether resonance attraction could really be operative in this way; after studying the question, we have reached the conclusion that the theory can not be applied in the ways indicated by him, and that his explanations of biological phenomena on this basis can not be accepted. In this note we wish to state our objections to Jordan's hypothesis and to formulate briefly our view of the present status of the chemical problems involved in these phenomena. We shall not discuss here Jordan's biological arguments for the occurrence of autocatalytic reactions, as distinct from the arguments concerning their mechanism.

Let us consider two identical molecules or parts of molecules, A and B, which interact with each other, the interaction being perhaps the electrostatic interaction of electric dipoles in the molecules, as considered by Jordan. If both molecules are in their lowest

[1] P. Jordan, *Phys. Zeits.*, 39: 711, 1938; *Zeits. f. Phys.*, 113: 431, 1939; *Fundam. Radiol.*, 5: 43, 1939; *Zeits. f. Immun. forsch. u. exp. Ther.*, 97: 330, 1940.

states the interaction is normal. If, however, one is in its lowest state and the other in an excited state there occurs a resonance phenomenon; the wave function is either the symmetric or the antisymmetric combination of two functions, one representing molecule A normal and molecule B excited, and the other the reverse. For one of these symmetry types there is a resonance stabilization and attraction between the two molecules, and for the other a resonance repulsion.

It is this resonance stabilization between identical molecules which Jordan invokes as the cause of his postulated process of synthesis of molecules similar to a molecule present in the cell. His argument requires, of course, that the stabilization occur only between identical molecules, or, at any rate, between molecules which differ only slightly. Moreover, since the phenomenon does not occur for two molecules in their lowest energy states, he assumes that there exist excited energy states differing from the lowest state by a small amount of energy ($\sim kT$), so that thermal excitation raises the molecules to these excited states.

Now let us examine Jordan's argument. In addition to those objections which the author himself has pointed out we may advance the following ones.

(1) The resonance stabilization between two identical molecules is equal to the resonance integral $H'_{n'_A n''_B,\ n''_A n'_B}$ (here n' and n'' are quantum numbers for the states involved in the resonance), which to be effective in determining the behavior of the system must be at least of the order of kT in magnitude. But *under the assumed circumstances the resonance between unlike molecules would be nearly as great as that between like molecules.*[2] If the two molecules A and B are unlike, but have excited states with nearly the same energy difference ($\sim kT$) from their normal states, then the resonance stabilization will be equal to the resonance integral; even if the energy values of the excited states for the two molecules differed by as much as one half the resonance integral ($\sim {}^1/_2 kT$), the resonance stabilization would still be about three quarters as great as for identical molecules.[3]

(2) For large molecules in solution, such as protein molecules, the complexity of the molecules and the perturbing influence of the environment would be such as to make the energy spectrum of a molecule effectively a continuum, and would wipe out the distinction between unlike and like molecules.

(3) The reasonance stabilization is equal to the resonance integral, and must be of magnitude kT or greater to be effective; *i.e.,* it must be as great as the energy difference between ground state and excited state. On the other hand, the theory requires the excited state which is involved to be non-degenerate. But by definition a "non-degenerate" state in perturbation problems is one for which the energy differences with all other states are greater than the resonance integral; hence Jordan's argument is inconsistent.

Summing up, then, we find that under the conditions of excitation and perturbation prevailing in aqueous solutions the resonance interaction could not cause a specific attraction between like molecules and therefore could not be effective in bringing about autocatalytic reactions.

It is our opinion that the processes of synthesis and folding of highly complex molecules in the living cell involve, in addition to covalent-bond formation, only the intermolecular interactions of van der Waals attraction and repulsion, electrostatic interactions, hydrogen-bond formation, etc., which are now rather well understood. These interactions are such as to give stability to a system of two molecules with *complementary* structures in juxtaposition, rather than of two molecules with necessarily identical structures; we accordingly feel that complementariness should be given primary consideration in the discussion of the specific attraction between molecules and the enzymatic synthesis of molecules.

A general argument regarding complementariness may be given. Attractive forces between molecules vary inversely with a power of the distance, and maximum stability of a complex is achieved by bringing the molecules as close together as possible, in such a way that positively charged groups are brought near to negatively charged groups, electric dipoles are brought into suitable mutual orientations, etc. The minimum distances of approach of atoms are determined by their repulsive potentials, which may be expressed in terms of van der Waals radii; in order to achieve the maximum stability, the two molecules must have complementary surfaces, like die and coin, and also a complementary distribution of active groups.

The case might occur in which the two complementary structures happened to be identical; however, in this case also the stability of the complex of two molecules would be due to their complementariness rather than their identity. When speculating about possible mechanisms of autocatalysis it would therefore seem to be most rational from the point of view of the structural chemist to analyze the conditions under which complementariness and identity might coincide.

From the biological side it would seem most rational to postulate the possibility of both processes; *viz.,* formation of complementary non-identical structures and formation of complementary identical structures,

[2] This is found to be so by evaluating the roots of the secular equation corresponding to the perturbation.

[3] The relation between the amount of resonance stabilization and the energy difference of the resonating states is given, for example, by L. Pauling, "The Nature of the Chemical Bond," p. 18. Cornell University Press, Ithaca, N. Y. 1940.

and to proceed by analyzing experimental data for clear-cut evidence as to their occurrence.

LINUS PAULING

GATES AND CRELLIN LABORATORIES OF CHEMISTRY,
CALIFORNIA INSTITUTE OF TECHNOLOGY

MAX DELBRÜCK

PHYSICS DEPARTMENT,
VANDERBILT UNIVERSITY

A NEW CALCULATION OF THE C=C BOND STRENGTH AND OF CERTAIN RESONANCE ENERGIES[1]

IN the current table of bond energies[2] used for interrelating the structures of molecules and thermal data relating to them and for predicting resonance energies, a strength of 100 is assigned to the C=C bond. (Bond strengths are given in kcal./mole units, bond lengths in Ångstroms.) This value appears to be at variance with the data relating to ethylene and allene.

The heat of combustion of gaseous ethylene[3] is 337.28. The heat of combustion of gaseous methane[3] is 212.79. Writing 4d for the amount by which the ethylene C–H bonds exceed the methane bonds in strength, we deduce that the C=C bond in ethylene has the strength 94.29-4d. Using the heat of hydrogenation[4] of ethylene 32.58 and the heat of combustion of ethane[3] 372.81, it follows that this bond strength is 94.51-4d. Correspondingly, from the heat of hydrogenation[4] of allene 71.28 and the heat of combustion of gaseous propane[3] 530.57, it follows that the strength of the C=C bond in allene is 92.57-2d′, where d′ is the amount by which each allene C–H bond exceeds the methane bond in strength. The C–H bond length[5] in ethylene and in allene is quoted at 1.087, which is smaller than the C–H bond length[2] in methane, quoted at 1.093. Hence it must be presumed that d and d′ are positive and that the C=C bond strengths in ethylene and allene are less than 94.29 and 92.57, respectively.

This considerable modification in the C=C bond strength implies a considerable modification in the resonance energies of benzene, naphthalene, etc., as at present defined.[2] For example, the resonance energy of benzene, defined as E–E′, where E is the heat of formation and E′ the sum of the strengths of 3C–C +3C=C +6C–H, is now increased by at least 17: naphthalene correspondingly, whose E′ function includes 5C=C bonds, has its resonance energy increased by at least 28, and for anthracene and phenanthrene the increase is at least 39. Other molecules have their resonance energies increased at least by the following amounts: pyridine, furan, pyrrole and thiophene 11, quinoline and indole, 22, carbazole 34, and so on.

DOROTHY WRINCH

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[1] Contribution from the Chemical Laboratory of the Johns Hopkins University, Baltimore, Md.

[2] Pauling, "Nature of the Chemical Bond," 1939, 1940.

[3] Rossini, *Ind. and Eng. Chem.*, 29: 1424, 1937.

[4] Kistiakowsky *et al.*, *Jour. Am. Chem. Soc.*, 58: 137, 1936.

[5] Eyster, *Jour. Chem. Phys.*, 6: 580, 1938.

AVOIDING OBVIOUS RESIDUE FROM NICOTINE–BENTONITE SPRAYS[1]

BECAUSE of reports, from many places, of the unsatisfactory obviously heavy residue on fruit and foliage resulting from the use of nicotine-bentonite combinations, we wish again to call attention to our experience.

Using Wyo-Jel bentonite obtained from the Wyodak Chemical Company, Chicago, Illinois, we proceeded first to wet weighed portions of bentonite, using a mechanical stirrer, before adding the nicotine. The spray resulting from this method left a very marked residue on fruit and foliage which was quite obvious from some distance. The trees gave the appearance of vegetation which has been covered with dust along a very dusty dirt road. McCrory and Vinson[2] described in 1938 a method of mixing nicotine sulfate (Black Leaf 40) and bentonite which gave *no obvious* residue when the material was used as a spray. The method consists in adding a known quantity of Black Leaf 40 to a weighed portion of *dry* bentonite. The materials are mixed *in the dry condition* with a stick or other suitable stirrer. The mixture is then allowed to stand in a tightly closed container over night. By the following morning the lumps crumble and all is passed through an eighteen-mesh screen. The screened combination disperses readily in the spray tank to form a stable suspension. Such a spray gives *no obvious* residue on fruit or foliage. Eight sprays of such a preparation in 1938 and six in 1939 resulted in *no obvious* residue. Certainly there was no suggestion from the appearance of the fruit at harvest that any kind of cleaning was necessary or desirable.

Control of codling moth by such a nicotine-bentonite combination gave results which compared very favorably with that obtained by the standard spray of lead arsenate. About eighty-seven thousand apples were counted from the sprayed plots in 1939. The percentage of clean fruit from plots sprayed with the nicotine-bentonite combinations was 92.4 and the percentage of clean fruit from the lead arsenate plot was 91.3. The number of entries was slightly reduced and the number of stings was greatly reduced under those for the lead arsenate.

C. G. VINSON
S. A. MCCRORY

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[1] Contribution from the Department of Horticulture, Missouri Agricultural Experiment Station Journal Series No. 634.

[2] S. A. McCrory and C. G. Vinson, *Mo. Agr. Exp. Sta. Res. Bull. No.* 292, 1938.

SOME RESULTS OF COLCHICINE INJECTIONS

INJECTIONS (Peter Gray method) of 0.02 cc of a 0.0001 per cent. solution of colchicine used on developing 24-hour chick embryos have shown the following results: (1) four of 20 injected eggs hatched, two males and two females; the hatched chicks have now reached the age of 9½ months, except for one hen which has been sacrificed for histological studies. (2) The combs and wattles in both sexes are abnormally large, approximately of twice the size of normal chickens. (3) Two of the tail fathers of the roosters have become greatly elongated. (4) The hen kept in the cage with one of the roosters lays non-hatching eggs at the rate of one every two or three days.

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SCIENTIFIC BOOKS

AVIATION MEDICINE

Principles and Practice of Aviation Medicine. By HARRY G. ARMSTRONG, B.S., M.D., Captain, Medical Corps, U. S. Army, and director, The Aeromedical Research Laboratory. 496 pp. Baltimore: Williams and Wilkins Company. 1939. $6.50.

AVIATION is becoming one of the major factors in history. Gunpowder overthrew the feudal system. Steam created the modern industrial civilization. Electricity and the petroleum motor have profoundly altered the conditions of modern life. But not one of these factors has ever, within so brief a period, exhibited a greater power to influence the course of history than has aviation. Even as these words are written, sea power, long the dominant force in international affairs, is challenged by power in the air.

For efficiency and safety in the use of any great discovery or invention two factors are required: perfection of matériel and selection and training of personnel—the machine and the mechanic—the gun and the man behind it. The railroad and the steamboat in their early days caused numerous fatalities, but these means of travel have gradually been improved until now a railroad train and a steamship are almost havens of safety. Modern industry has involved many new health hazards—chiefly those of industrial poisoning—which medical science is now striving to control. In these illustrations the requirements of safety apply more to improvements in the machines and industrial methods than to the human element. Careful selection of personnel is rarely needed. In aviation, however, the balance is the other way. Even when the machines of flight were in their crude beginnings, the crashes and fatalities due to the human element were many times more frequent than those due to mechanical defects and failures. And, as experience has accumulated, the advances in aerial engineering have greatly diminished the hazards of the matériel of flight, while the hazards involved in the personnel—those inherent in the nature of the aviator—have been relatively far less effectively counteracted. Hence the need for the new science of aviation medicine—the physiology of man in the air.

Man is not naturally an aerial animal. In his construction there are, indeed, finely designed instruments, notably the vestibular apparatus and semicircular canals of the ear, which serve his cousins the monkeys admirably in controlling the muscular coordination of long swings and leaps from the limbs of one tree to another. But in the monkey, as in the tumbler of the gymnasium and the trapeze performer of the circus, the individual himself makes the initial movement, which the organ of equilibrium enables him an instant later to meet with a counteracting movement. Not so the aviator. If a movement of the airplane, in which he is passive, swings him in one direction, the stimulus to the inner ear, instead of inducing a righting reaction, may induce a so-called "forced movement," which, instead of leading to recovery of equilibrium, may hurl the plane and himself to destruction.

In the book here under review the chapters (XIV and XV) dealing with "aerial equilibration and orientation" and with "air sickness" have on this account the greatest general interest. It is clearly shown that the two functions of the ear—equilibrium and hearing—are entirely distinct. "Man on the ground maintains himself and orients himself in relation to his environment by means of sensory impressions from his eyes, vestibular apparatus, deep sensibility (muscle, joint and tendon sense), viscera and skin." In the air even vision, the most important of the senses, becomes inaccurate. As the height above the ground increases, the tilt of the plane becomes increasingly difficult to judge. In "blind flight" and at great altitude the pilot must adjust the level of his plane by an artificial horizon—a gyroscope; and must often act directly against what his sensations dictate. The senses of equilibrium and sight are both misleading, and "the messages sent to the brain are false." More reliable, perhaps, are the somatic senses which enable the pilot to "fly by the seat of his pants."

"Airsickness" is essentially the same disorder as seasickness. Persons susceptible to one are susceptible to

the other, but no ship on the sea ever tossed and pitched and rolled its crew and passengers as does an airplane in "stunting" or in "bumpy" air. But why the vestibular apparatus induces this misery is no clearer in relation to airsickness than to seasickness.

Wholly distinct are the effects of anoxia: the condition induced by the decreased pressure of oxygen at great altitudes. As a name for this condition the author adopts the term "altitude sickness." He shows that it is essentially the same as the "mountain sickness" which has been the object of so much interest to physiologists from the studies of Paul Bert down to the present time. Like the "mountain sickness" of the alpinist the "altitude sickness" of the aviator occurs in two forms; the acute form in which oxygen deficiency for a brief period abolishes muscular coordination and control and even consciousness, and the chronic form resulting from repeated subacute exposures and resembling the "staleness" of the over-trained athlete.

Under the term "aeroembolism" a condition is postulated for aviators in rapid ascents to extreme altitudes essentially like the caisson disease, which is the result of too rapid decompression after work under compressed air in deep diving and subaqueous tunneling. In how far such effects can occur at the altitudes now commonly attainable is still uncertain; but if the stratosphere is to be invaded this hazard, as well as that of "altitude sickness," will have to be met. It will require that the air pressure in the cabin of the plane shall be kept up at least to that of an altitude of 10,000 feet.

Excellent discussions are given of the requirements for the aviator in respect to his eyes, ears, throat, lungs, heart, nervous system and his neuropsychic character. The care that must be taken of his health, physical and mental, equals or exceeds that for the athlete in strict training. Aviation is a profession that makes such demands on both body and mind—particularly the mind—as no other calling has ever made before.

With these considerations before us it needs no argument to establish the enormous importance of aviation medicine. Without this new science there can be no safe commercial aviation and no efficient military aviation; and without an efficient aviation corps no nation can now be immune from attack. This book is the first in its field in America, and is therefore a contribution of great importance. It is encyclopedic in scope, and for the most part accurate in details. Only on two topics, which happen to fall within the reviewer's competence, has it gone astray. They are the so-called "chronic carbon monoxide asphyxia" (pp. 174–75), and the history of the initial investigations in America on pilot fitness (pp. 10 and 34).

As regards carbon monoxide the curve quoted for the blood concentration is that for equilibrium: its values would be attained only after infinite time. The curve that would express the concentrations in the blood after finite periods of exposure would have ordinates only about half as great. Equally misleading are the statements quoted in regard to so-called "chronic carbon monoxide poisoning." They are taken from one of the numerous clinical writers who, knowing next to nothing about carbon monoxide asphyxia, find it convenient to diagnose their neurotic and hypochondriacal, but quite unexposed, patients as suffering from this alleged chronic disorder. Further investigation of this topic is important in connection with aviation; for, as the author recognizes, any appreciable amount of carbon monoxide in the blood adds to the strain of low oxygen and the resulting "altitude sickness."

The author's failure to do justice to the initial American investigations on "pilot fitness" arises from his having entirely overlooked the papers in which they were first reported.[1] Accordingly, he credits to European sources ideas and discoveries that were really American. He makes such statements as that "The Flack [British] bag was the prototype of the first rebreathing apparatus developed in the [American] Medical Research Laboratory." Actually the reviewer had been using such an apparatus for the laboratory instruction of students for several years before the United States entered the war. During those years two men of outstanding scientific ability, Edward C. Schneider and James L. Whitney, had carried on investigations in my laboratory. Accordingly, when I was asked to organize the laboratory and plan the research work on pilot fitness, I centered it on the so-called "rebreather" as the simplest means of imitating altitude, and called Schneider and Whitney into the aviation service. Their work with the "rebreather" marked the beginning of thorough scientific study anywhere on the capacity of pilots to withstand low oxygen. We got little or nothing from foreign sources for the very good reason that at that time there was almost nothing to get. How clear is the case for American priority in this field is demonstrated by the recent investigations of Krogh and Christensen[2] in this field which they recognize to have developed from this pioneer American work.

The format and typography of the book are of the high grade that we have learned to expect from its publishers.

YANDELL HENDERSON

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[1] *Journal* of the American Medical Association, 26: 1382–1400, October 26, 1918.

[2] *Skand. Arch. Physiol.*, 73: 17 and 145, 1936.

SOCIETIES AND MEETINGS

THE ACADEMY CONFERENCE[1]

THE Academy Conference held its thirteenth annual session in the Deshler-Wallick Hotel at Columbus, Ohio, on the afternoon of December 27, 1939.

The conference is composed of (1) representatives named for membership in the council of the American Association for the Advancement of Science by the academies and (2) members of the executive committee of the association. Each affiliated academy names one representative to be a member of the council of the association and that representative is *ex-officio* a member of the Academy Conference. In addition the Academy Conference welcomes the attendance of anyone interested in the interrelationships of the academies and the association. The object is to promote cooperation among the affiliated academies and between them and the association. The officers consist of a chairman, a vice-chairman and a secretary. A vice-chairman is elected at each annual meeting, and he in turn becomes the chairman the succeeding year.

Those present included:

Members of the Executive Committee of the American Association for the Advancement of Science:

J. McKeen Cattell, Garrison, N. Y.
Otis W. Caldwell, Boyce Thompson Institute, Yonkers, N. Y.
Burton E. Livingston, Johns Hopkins University, Baltimore, Md.

Representatives from the Affiliated Academies:

Alabama Academy of Science
J. H. Coulliette, Birmingham Southern College, Birmingham, Ala.
American Institute of the City of New York
Robert T. Pollock, 570 Lexington Ave., New York, N. Y.
British Columbia Academy of Sciences
C. McLean Fraser, University of British Columbia, Vancouver, B. C., Canada
Colorado-Wyoming Academy of Science
F. E. E. Germann, University of Colorado, Boulder, Colo.
Georgia Academy of Science
A. S. Edwards, University of Georgia, Athens, Ga.
Illinois Academy of Science
Lyell J. Thomas, University of Illinois, Urbana, Ill.
Indiana Academy of Science
Howard E. Enders, Purdue University, La Fayette, Ind.
Iowa Academy of Science
Joseph C. Gilman, Iowa State College, Ames, Iowa
Kansas Academy of Science
Roger C. Smith, Kansas State College, Manhattan, Kansas
Kentucky Academy of Science
Austin R. Middleton, University of Louisville, Louisville, Ky.
Louisiana Academy of Science
W. H. Gates, Louisiana State University, Baton Rouge, La.
Maryland Academy of Science
S. Karrer, 2724 N. Charles St., Baltimore, Md.
Michigan Academy of Science
A. Franklin Shull, University of Michigan, Ann Arbor, Mich.
Minnesota Academy of Science
H. K. Wilson, University Farm, St. Paul, Minn.
Missouri Academy of Science
R. T. Dufford, University of Missouri, Columbia, Mo.
Mississippi Academy of Science
Clay Lyle, Mississippi State College, State College, Miss.
Nebraska Academy of Science
W. C. Brenke, University of Nebraska, Lincoln, Nebr.
New Orleans Academy of Science
E. C. Faust, Tulane University School of Medicine, New Orleans, La.
North Carolina Academy of Science
Bert Cunningham, Duke University, Durham, N. Carolina
Ohio Academy of Science
William H. Alexander, Hotel Normandie, Columbus, Ohio
Pennsylvania Academy of Science
V. Earl Light, Lebanon Valley College, Annville, Pa.
South Carolina Academy of Science
G. H. Collings, Clemson College, Clemson, S. Carolina
Tennessee Academy of Science
F. G. Slack, Vanderbilt University, Nashville, Tenn.
Texas Academy of Science
S. W. Bilsing, A. & M. College of Texas, College Station, Texas
Virginia Academy of Science
Edgar C. L. Miller, Medical College of Virginia, Richmond, Va.
West Virginia Academy of Science
P. D. Strausbaugh, West Virginia University, Morgantown, W. Va.
Wisconsin Academy of Sciences, Arts, and Letters
E. M. Gilbert, University of Wisconsin, Madison, Wis.

Guests attending the Academy Conference:

Karl F. Oerlein, State Teachers College, California, Penna.
Don O. Baird, Sam Houston State Teachers College, Huntsville, Texas
H. H. Sheldon, New York University, New York, N. Y.

Dr. Cunningham, the chairman, opened the conference. The secretary stated the procedure which has

[1] Columbus meeting, held in conjunction with the annual meeting of the American Association for the Advancement of Science.

been followed in past years in the election of officers. It has been the custom to elect at the beginning of the session a vice-chairman who assumes office at the close of the business session of the succeeding meeting. This custom of having the chairman assume the chair in the middle of the session has not been satisfactory. After discussion, it was moved, seconded and voted that the chairman, Dr. Cunningham, preside throughout the present session and that the vice-chairman, Dr. Gilman, serve as chairman during the next session of the conference. A committee was appointed to nominate a vice-chairman. This committee, E. C. L. Miller, Roger Smith and Ernest Carrol Faust, presented the name of P. D. Strausbaugh. The recommendation was unanimously approved.

The following program was then presented:

(1) Report of the Subcommittee Appointed to Confer with the American Institute on Problems of the Junior Academy. H. E. Enders, Indiana Academy of Science.

(2) Report on (*a*) The Usefulness of the Academy Research Grants of the A.A.A.S.—in Retrospect and in Prospect; (*b*) On What Basis Should Junior A.A.A.S. Membership Awards be Made. E. C. Faust, New Orleans Academy of Science.

(3) Can the Academy Serve as a Unifying Agent for the Various Scientific Organizations of the State? P. D. Strausbaugh, West Virginia Academy of Science.

(4) The Organization of a State Academy of Science. J. C. Gilman, Iowa Academy of Science.

The special committee of representatives of the conference chosen at the Richmond session in 1938 to consider the relationship between the Junior Academy and the American Institute of the City of New York met in Indianapolis, Indiana, on February 11, 1939. This committee was composed of Otis W. Caldwell, representing the executive committee of the association; Bert Cunningham (North Carolina Academy); J. C. Gilman (Iowa Academy); E. C. L. Miller (Virginia Academy); H. H. Sheldon, American Institute of the City of New York; Lyell J. Thomas (Illinois Academy), and H. B. Enders (Indiana Academy). Louis A. Astell, of the Junior Academy in Illinois, was invited to meet with the committee. Dr. Miller was chosen chairman and Dr. Enders, secretary. The committee considered:

(1) The Aims, Objectives and Organization of Junior Academies of Science.

(2) Aims of the American Institute.

(3) Possible Cooperative Relations with the American Institute in the Development and Promotion of Junior Academy Clubs.

(4) Unification of Science Club Work through Cooperation.

In order to develop a plan to promote high-school science clubs as independent groups or as units of the State Senior Academies of Science the following motions were passed by the committee.

(1) *In states which have a State Academy of Science and a Junior Academy of Science,* any inquiring science club seeking admission to the "Associated Science Clubs" is to be referred to the Junior Academy of Science of the state in which the club is located, for assignment of its membership.

(2) *In states which have no State Academy of Science* and no organized high-school science clubs, any organization of its science clubs shall bear the name "Associated Science Clubs" rather than the name "Junior Academy of Science."

(3) *In states which have no State Academy of Science* any inquiring high-school science club seeking admission to the "Associated Science Clubs" shall be referred to the particular state of its location for membership and be known as the "Associated Science Clubs of ————" (the state as the geographic unit).

(4) *In any state which has an organized State Academy of Science, but no Junior Academy of Science,* it is advised that if or when ten or more high-school science clubs are organized, the general secretary of the American Association for the Advancement of Science be directed to recommend to the existing State Academy of Science an initial establishment of a Junior Academy of Science.

The committee also recommended a continuing committee be set up by the Academy Conference to promote the interests of science clubs.

E. C. Faust (New Orleans Academy) presented a summary of a study of "The Usefulness of the Academy Research Grants of the American Association for the Advancement of Science in Retrospect and in Prospect."

The selection of a grantee or grantees by the academy appears in most cases to be by special committees or members of the Executive Committee of the Council of the State Academy. The general trend is to grant funds to individuals who otherwise would be seriously handicapped in their research.

An analysis of the types of research projects shows that out of a total of 162 projects, 42 were undertaken in physical sciences, 112 in biological sciences and 8 in social and applied sciences. One half of the grantees in the biological sciences undertook problems in the field of natural history and taxonomy.

One third of the money was expended for materials and equipment: some for travel and field expenses and collection of material away from the place where the investigation was being conducted, some for photographs and illustrations; some for technical assistants and statistical aid, and a small percentage for library facilities. More than one third of all the grantees have not furnished information as to the use of the money. Between 1935 and November, 1939, there were 178 grants from funds made available by the American Association for the Advancement of Science. In 1936,

44 per cent. of the grantees published at least one paper each, resulting from the utilization of the funds made by the grants. In 1937 approximately the same number of papers were published by grantees. In 1938 approximately 40 per cent. of the grantees published the results of their investigation. In 1939 up to November 1, 227 of the grantees had already published as a result of the 1939 grants.

The following conclusions have resulted from this inquiry:

(1) The grant is usually made by a special committee responsible either to the academy as a whole or to the executive group of the academy.

(2) Approximately three fourths of all the grants have been made to persons working in the group of biological sciences, and of this number more than one half have selected research problems in the field of natural history and taxonomy. This might suggest that grantees either may not have modern points of view or may not be scientifically prepared to undertake research in more dynamic aspects of their subjects. Research grant committees of the academies should make serious study of the type of problem for which the grant is requested, so that the academies and the association may contribute to productive research.

(3) With an increase in the number of grants made each year through the academies, there has apparently been an increase in the publication each year, although some of the publications consist only of preliminary abstracts or progress reports which apparently are not followed within a reasonable time by publication of complete results.

(4) Secretaries of the academies should keep complete and up-to-date information on the development of the grantees' projects. This information should be required from grantees.

Dr. Faust also distributed a mimeographed copy not here included of an analysis of junior membership in the American Association for the Advancement of Science.

P. D. Strausbaugh (West Virginia Academy) presented a paper on "Can the Academy Serve as a Unifying Agent for the Various Organizations of a State, and How May This Be Done?"

In order to ascertain the interest in such a subject in other academies the following questions were submitted to the Academy Conference representatives:

(1) Has your Academy of Science made any attempt to bring the various scientific organizations of the state into affiliation with the academy?

(2) If not, do you think the State Academy should function as such a unifying agency?

(3) In your opinion, how should the academy proceed to effect such an affiliation of the various scientific organizations within the state?

Replies were received from 20 representatives. Seventeen of these expressed positive interest; five reported considerable progress; two were doubtful, and one was not interested.

Five academies have already succeeded to a degree in bringing about an affiliation of a number of organizations.

In Kansas a committee on affiliation was first appointed in 1931. Several meetings of representative groups have been held, and the Kansas Academy intends to carry on this program of affiliation.

The Iowa Academy meets regularly with the Iowa Section of the Mathematical Association of America and the Iowa Section of the American Association of University Professors.

The Colorado-Wyoming Academy has from its beginning been a strong advocate of the idea of the unification of scientific interests. For several years the Colorado-Wyoming Academy has had permanent affiliation with the Colorado-Wyoming Social Science Association and the past year the Colorado Anthropological Society met with the academy.

In Missouri, the state Audubon Society, the Missouri Section of the Mathematical Association of America and the Speech Association of Missouri regularly meets with the Missouri Academy. In addition, the American Association of University Professors and the various local medical associations have met with the Missouri Academy at various times, and a group which belongs to science clubs in the various colleges and junior colleges constitutes a section of the Missouri Academy.

Affiliated with the Texas Academy are 15 senior societies, nine collegiate chapters of the academy and 15 chapters of the junior academy. The affiliated organizations have a conference which is very similar to the academy conference. This conference of affiliated societies consists of the presidents and secretaries of these societies and the academy's representative to the American Association for the Advancement of Science. The conference holds its meetings in conjunction with the annual meetings of the academy.

From the evidence it is concluded that the academy can function as a unifying agent to secure affiliation of other scientific organizations within the state. The desirability of such an affiliation can scarcely be denied. Tactful approach is a necessity if success is to be achieved. The dominant idea must be the greater service through a closer cooperation of all the state organizations concerned with the advancement of scientific interest.

The next paper, "The Organization of an Academy," was read by J. C. Gilman, of the Iowa Academy.

All the academies have one common objective—the advancement of science within their territory. Each academy meets at least once a year and some of them

meet more often; some support a publication, some have a library and a few have museums.

Many academies divide their membership into the following classification: honorary fellows, fellows, members. Several academies have junior academies, but few provide a separate classification for college students. The Iowa Academy has instituted a new class, "fellow emeritus," for persons who have been fellows for 25 years and because of retirement are no longer financially able to pay their dues. Life memberships are provided by most academies upon payment of an amount of money which is designed to bring the academy sufficient interest to cover the annual dues.

The secretary is the most important officer in the organization. He should hold his position for a period of years.

The executive committee formulates the policies of the academy, and, therefore, its members should be active in academy work. In most academies the officers constitute the executive committee. Section chairmen in some academies also serve on the executive committee.

Some academies meet as a body, while others are divided into sections, the Missouri Academy having 20 sections, and the other academies a lesser number. The interrelations between the branches of science seem to indicate that a simpler arrangement with opportunity for workers in interrelated fields to get together might be a better method of organization.

Most academies meet once a year, but a few meet more frequently. The time for the spring meeting is becoming more and more a problem because of the fact that many other organizations hold spring meetings. Would it be possible for all the academies to set aside a week or a week-end in which the academies would meet? Such an arrangement would serve their common interests and enable academies in adjoining states to meet together.

In the field of intersociety relationships there are many opportunities. The Academy Conference is a step in the right direction, but it has a long way to go. The Academy Conference enables representatives of the academies to meet and discuss common problems. It is desirable that the representatives of the various academies should be continued in that capacity over a period of years. It requires some time to become familiar with the functions of the Academy Conference. If the academies would give their representatives the power to act on inter-academy matters, it would strengthen this body considerably.

It is desirable that other local scientific organizations be invited to accept the advantages which result from affiliation with the academy. If the academy could be made the rallying point for these groups, both the local societies and the academy would profit from these relationships.

The effective academy is one with an active group of officers and continuing secretary, whose executive committee, made up of those officers and the chairmen of the standing committees, is an alert group which adequately directs the work of the academy, not only its internal affairs but also its relations to the state in which it is situated. Further, it should be closely affiliated with the American Association for the Advancement of Science and with any other scientific bodies of its particular locality. Such a group is a potent guiding force wherever it may be found.

S. W. BILSING

COLLEGE STATION, TEXAS

REPORTS

GRANTS FOR RESEARCH OF THE GEOLOGICAL SOCIETY OF AMERICA

TWENTY-NINE grants in support of special research projects were authorized by the council of the Geological Society of America at the April, 1940, meeting, as follows:

George P. Woollard, fellow, National Research Council, Princeton, New Jersey, is starting a gravimeter traverse which is expected to complete a line from Washington, D. C., to Los Angeles. Data on the Washington to Pittsburgh portion of the traverse are already available. The gravimeter has been made available by the Humble Oil and Refining Company. The study should yield knowledge of the fundamental structure of North America comparable to that relative to the structure of island arcs provided by the work of Meinesz and collaborators. It is a study by gravitational, geological and magnetic methods of the deeper parts of the earth's crust and the relations of anomalies to continental structure. The work will continue throughout the coming summer. $3,000.

W. J. Mead, Massachusetts Institute of Technology. Under the cooperative direction of Professors Mead and Robley Evans the question of the reliability and limitations of the helium method of determining the age of rocks will be investigated. Dr. Clark Goodman will continue in immediate charge of the work. Three large masses of igneous rocks will be sampled for age determinations on their various parts and phases. The ultimate objective of the investigation is the establishment of a reliable means of determining the age of igneous rocks and the development of an absolute time scale for the geologic column. $3,300.

Bruce L. Clark, University of California, Berkeley, received an additional sum for the completion of his studies of the Cretaceous and Tertiary Radiolaria of western North America. $100.

Charles L. Camp, University of California, Berkeley, will continue the compilation of a bibliography of vertebrate paleontology for the period 1934 to 1938. The period 1928 to 1933 has already been covered, and a manuscript awaits publication by the society. The new volume is approximately half finished. $1,500.

Chester Stock, California Institute of Technology, will continue his work on Tertiary fossil fish faunas of the Pacific Coast with the assistance of Dr. Lore R. David. The work is an extension of an earlier project and is expected to complete the study. $1,000.

Norman D. Newell, University of Wisconsin, will devote the latter part of the coming summer to a revisitation of the Wind River Mountains and adjoining ranges in western Wyoming to study the stratigraphy and paleontology of the Dinwoody formation. The purpose of the study is to locate the Permo-Triassic boundary and to study the Permian history of the northern Rockies and adjoining parts of the Cordilleran geosyncline. $350.

John T. Hack, Harvard University, will resume his studies of the genesis of certain circular structures in the Hopi Buttes country of Arizona. Dr. Hack has spent several seasons in the district and has discovered 50 or more of these structures, the average diameter of which is 3,000 feet, and which he believes are explosive vents rather than cauldron subsidences as interpreted by other workers. Four to six weeks will be spent in the field during the coming summer. $200.

John A. Allan, University of Alberta, will spend five weeks on a pack train field survey within the eastern slope of the Canadian Rockies in western Alberta. A number of trips into the area have been made in past years, and with the completion of the project contribution will be made to the knowledge of the Rocky Mountain geosyncline. The geological section will be made between latitudes 52° and 53° in the vicinity of the North Saskatchewan valley and will complete a section extending westward from the front thrust at least as far as the Continental Divide. $700.

Arthur D. Howard, New York University, Washington Square, will continue his study of the pediment gaps of the Sacaton Mountains of Arizona. The pediment gaps are low cols in the divide at the heads of the pediment embayments and they have a possible bearing on the origin of the pediments. To date pediment gaps are the only important features associated with pediments which have not been examined critically in the field. Dr. Howard expects to spend four weeks in the field during the coming summer and thereby round out available information on the origin of pediments. $215.

Frank F. Grout, University of Minnesota, will maintain the laboratory for rock analyses of research grade with the assistance of this additional grant to guarantee continued operation. The laboratory contributes to a great variety of fundamental problems such as the composition of the earth's crust, the differentiation and contamination of magmas, diagenesis of sediments and the processes of metamorphism. The laboratory has been aided since October, 1934, has proven to be of inestimable service to petrologic research and is patronized by a large number of research workers. More than 800 analyses have been made. $2,000.

Vladimir J. Okulitch, University of Toronto, will extend his researches on the American Pleospongia from fields already studied in eastern Canada to include the collections at the United States National Museum and the Museum of Comparative Zoology at Harvard. This work will complete the description of the American representatives of this class heretofore practically unknown and will make the material available for comparison with that already described for Australia, Siberia and Europe. $130.

Max Demorest, Sterling fellow, Yale University, will continue work now in progress on field studies of glacial petrofabrics and laboratory research on the physics and deformation of ice. This work has been supported by two previous grants. During the coming summer Dr. Demorest will spend ten weeks at Mt. Rainier making petrofabric determinations of ice orientation and its relation to the various stress conditions found in the glaciers. He will continue his cold storage laboratory experiments at New Haven during the succeeding academic year and through the summer of 1941. The work at New Haven is also supported by a National Research Council fellowship. $1,000.

A. J. Eardley, University of Michigan, will spend a month in Utah to complete geologic mapping in a study of the physiography and structure of the north-central Wasatch Mountains. He will examine the pre-Pennsylvanian and post-Cambrian stratigraphy for the solution of certain fault problems and will contribute further details on the Laramide and Basin Range deformations. $200.

Lincoln Dryden, Bryn Mawr College, will supervise the sampling and heavy mineral analysis of Triassic sediments of the Atlantic Coastal Plain. Professor Dryden has been working on the heavy minerals of the Piedmont and Coastal Plain for several years and will now extend his studies over to the Triassic sediments. Several hundred samples will be analyzed, and it is hoped that the results will contribute to a knowledge of the source of the Coastal Plain and Triassic sediments and to the drainage problems of the region. $300.

Ray E. Wilcox, University of Wisconsin, will return to the Yellowstone plateau to continue his study of the origin of mixed rhyolite-basalt rocks already investigated on Gardiner River. Dr. Wilcox will investigate the role of assimilation in the production of the mixed rocks, as well as the possible mixing of simultaneous outpourings of true lavas, and hopes to contribute data on the areal relationships between possible co-existing magma chambers. $500.

Francis Birch, Harvard University, received assistance for his research looking to the determination of the velocity of propagation of shear weaves and rigidity of igneous rocks. This is a laboratory research producing pressure and temperature conditions supposed to exist in a 30-km crust. Pressures up to 10,000 kg/cm^2 and temperatures up to 600° C. will be applied simultaneously. The results of the investigation will contribute toward a solution of the fundamental question of the constitution of the upper layers of the earth. The work is a part of the program of researches in experimental geology and

geophysics at Harvard under the joint guidance of Professors Daly and Bridgman. $3,600.

Charles S. Denny, Dartmouth College, will study glacial deposits in the Hanover-Canaan area, New Hampshire, with view to determining the manner in which the last ice sheet disappeared from that region. A study will be made of the abundant water-laid glacial deposits and dry stream channels on hillsides apparently formed by ice marginal drainage and will throw light upon the current belief that, in Wisconsin deglaciation, down wastage played the leading part. $225.

Frank M. Carpenter, Harvard University, will spend July and August in Perry County, Oklahoma, collecting from the Wellington formation material containing Permian insects. Dr. Carpenter has studied insects from the nearly contemporaneous Elmo limestone of Kansas, but apparently those faunas existed under very different environmental conditions, for the Oklahoma insects are decidedly different. The project will contribute to knowledge of Permian insects and to general problems of Permian stratigraphy. The American Academy of Arts and Sciences will also support the project. $300.

Margaret F. Boos, University of Denver, will investigate the pegmatite dikes and wall rocks associated with various granite plutons of the Front Range in Colorado, specifically the inclusions and replacement minerals. It may be possible to determine which pegmatite dikes belong to each successive plutonic invasion or to determine the waves of replacement, assuming that the dikes were established by the first mineralization and were later modified by solutions moving along the established avenues. $350.

A. K. Miller, State University of Iowa, received an additional sum to aid in completion of a monograph on Ozarkian and Canadian cephalopods initiated by Drs. Ulrich and Foerste. Drs. Miller and Furnish will rephotograph much of the material to be described in the monograph. $400.

Samuel S. Goldich, Agricultural and Mechanical College of Texas, and Morris A. Elms, San Antonio, Texas, will complete the mapping of the geology of the Buck Hill quadrangle of Brewster County, Texas. This includes part of the Davis Mountains, whose structure and petrology are quite complicated. The grant will be used largely for a petrologic and chemical study of a series of basalt, andesite, trachyte and rhyolite flows which, with intercalated ash beds and conglomerate, aggregate over 1,000 feet in thickness. The chemical and petrographic studies will indicate probable relationships and assist in the solution of the stratigraphic and structural problems. $350.

Stanley S. Ballard and John H. Payne, University of Hawaii, will secure improved analytical equipment to continue periodic analyses of solfataric gases at Kilauea volcano, and have gas-collecting equipment in readiness for the next suitable eruption of Mauna Loa and Kilauea. The grantees are respectively assistant professor of physics and assistant professor of chemistry at the University of Hawaii. The program of research has been under way for over three years with regular monthly analyses since September, 1938. The purpose of the research is to obtain a series of reliable analyses of the gases from a well-established solfatara (the "Sulphur Banks" of Kilauea) and to study the possible correlations between such gases and volcanic activity. $450.

Loris S. Russell, University of Toronto. The stratigraphy of the interior plains of Canada, under study for many seasons and partly described in the literature, will be rounded out during the coming summer by examination of key areas in western Canada not heretofore studied. Following the field work Professor Russell will prepare a general treatise on the stratigraphy of the region. $450.

Earl Ingerson, Geophysical Laboratory, will make a detailed field study of some of the gold-quartz veins of the Mother Lode of California, including mineral orientation, in an effort to obtain new and more definite information about the mode of emplacement of the veins and their subsequent history. It is hoped to contribute to knowledge of mineral orientation in veins of this type and possibly of the motion of solutions and conditions of pressure obtaining at the time of vein filling. Dr. Ingerson will enjoy full cooperation of Dr. Farmin of the Idaho Maryland Mines Corporation. $600.

Alfred R. Loeblich, Jr., and Helen Tappan Loeblich, University of Chicago, will collect and study foraminiferal material from the Lower Cretaceous Washita group of southern Oklahoma and northern Texas. It is proposed to determine the stratigraphic range and areal distribution of the species of Foraminifera and to study their environmental habitats. Phylogenetic relationships of the Washita Foraminifera to the Upper Cretaceous species of this region and to those of similar age in Europe are to be investigated. $250.

Rousseau H. Flower, University of Cincinnati, will visit museums in Ottawa, Washington, Albany, Cambridge, Chicago and Columbus to study collections of Devonian Nautiloidea and to prepare photographs and descriptions for a monographic treatment of these fossils. $500.

Frank M. Anderson, Berkeley, California, will complete his long-continued investigation of the stratigraphic, lithologic and faunistic features of the Upper Cretaceous sequence in California and Oregon. The project carries forward the grantee's general plan of supplying criteria for emending the past views as to the later Mesozoic on the American west coast, including the later Jurassic, the early Cretaceous, and upper Cretaceous. Paleogeographic data will be contributed. $300.

Robert L. Nichols, Tufts College, will (1) complete his studies of the "Aa flow of Lava Butte, Oregon," will (2) study a fissure about twenty miles long from which more than ten flows have been extruded, and will (3) study flows in the Lava Cast forest of Oregon with particular attention to the position and shape of "lava trees." Several weeks have been spent in these areas in the past, and the purposes of the new studies are to determine the velocity of lava flow from the shape of lava trees and flow mechanism of an aa flow. $280.

H. U. Sverdrup, Scripps Institution of Oceanography, will direct an expedition for the geological exploration of the central Gulf of California. The oceanographic vessel, "E. W. Scripps," will be used for a period of eighty days as a base for investigations of the submarine configuration, sedimentation and current dynamics of the sea floor and reconnaissance study of parts of the surrounding

coast. The primary purpose of the expedition is to obtain information on the developmental stages of what may be a modern geosyncline. The oceanographic work by Roger Revelle and F. P. Shepard will produce data regarding the environment of deposition of the marine Tertiary, especially the Miocene diatomaceous shales, rate of accumulation of diatomaceous muds, causes of the laminations in them and significance of their organic content as a possible source of petroleum, information on the tectonics of the area with possible data bearing on the southward continuation of the San Andreas fault system, and new information on submarine canyons. The land exploration will be carried out by W. S. W. Kew and C. A. Anderson in virtually unexplored territory difficult of access and of unusual interest. Studies of the marine Tertiary and of the thick interbedded volcanics should yield information on the structure and earlier development of the great depositional basin. $2,500.

G. E. Condra, University of Nebraska, with the assistance of M. K. Elias, will continue the photographing and description of his large collections of Pennsylvanian and Permian Bryozoa in the preparation of monographic reports. Through many years Professor Condra has collected systematically through the Mid-Continent region and in New Mexico, Arizona, Utah, Wyoming and South Dakota. He has collected in Russia and studied the collections in Perm, Moscow, Leningrad, Stockholm, Copenhagen and London. The acquisition of material from the Glass Mountains of Texas and from Greenland has made the Nebraska collection the largest in the world. Work is already three quarters complete and will be continued through the remainder of the year. $1,400.

SPECIAL ARTICLES

THE SUSCEPTIBILITY OF CHICKS TO DIPHTHERIA BACILLI AND TOXIN

IN 1884 Loeffler[1] described the effect of introducing virulent diphtheria bacilli into various birds and animals. Guinea pigs and rabbits were found to be especially susceptible. Later workers abundantly confirmed the latter findings of Loeffler, and these two animals were adopted, to the virtual exclusion of all others, in the study of diphtheria. From the work of Behring, Erlich and others upon measurements of toxin and antitoxin, the 250-gram guinea pig became the standard for such purposes and remains so to-day.

Among other tests made by Loeffler were those on several species of birds. Of thirteen finch-like birds or canaries inoculated intramuscularly with different strains of diphtheria bacilli, all died and at autopsy the organisms were found in large numbers in the tissues immediately surrounding the site of inoculation. All but one of eleven pigeons inoculated by various routes also succumbed to the infection. The effect of inoculating chickens ("fowls") intratracheally was less definite, although membrane-formation in some was observed. In 1899 Salter[2] reported that typical diphtheria bacilli were pathogenic for sparrows, finches, yellow-hammers and the thrush, on the basis of a small number of observations. The studies of Loeffler and Salter on birds were apparently never pursued further.

While retesting the pathogenicity of the diphtheria group of organisms for various species of birds and animals, it was noted that 7-day-old chicks regularly succumbed, following subcutaneous or intraperitoneal inoculation of strains of *Corynebacterium diphtheriae* known to be virulent for rabbits. Subsequent studies showed that death of the chicks rarely followed the inoculation of rabbit-avirulent diphtheria bacilli or diphtheroids. Moreover, as little as one guinea-pig-M.L.D. of diphtheria toxin regularly killed the chicks, while a high degree of protection was afforded by a previous injection of diphtheria antitoxin. Brief details of these experiments follow.

The cultures of *C. diphtheriae* were isolated during the course of local and nation-wide surveys, in which over 2,000 strains of diphtheria bacilli[3,4] were obtained from healthy carriers and persons with diphtheria. All these strains had previously been examined in this laboratory, and tested for virulence by the intracutaneous method in rabbits, developed by Fraser and Weld.[5] Strains referred to in this study will be designated as "virulent" or "avirulent" on the basis of that test. The organisms used in the experiments described in this paper were incubated for 48 hours in infusion-broth; 0.5 cc being the usual dose.

In a preliminary experiment, week-old White Leghorn or Barred Plymouth Rocks were inoculated subcutaneously in the back near the insertion of the right wing with six different strains of virulent organisms, among which were strains of the gravis, mitis and intermediate types. Of eighteen chicks inoculated, all died within 48 hours, regardless of type of organisms or breed of chick used. Six chicks, previously injected intraperitoneally with 100 units of diphtheria antitoxin, when inoculated with the same six virulent cultures, survived with no evident illness. Likewise, four chicks inoculated with four different strains of avirulent *C. diphtheriae* remained well.

[1] F. Loeffler, *Mitth. a. d. k. Gsndhtsamte.*, 2: 421–99, 1884.

[2] A. Salter, *Trans. Jenner Inst. Prev. Med.*, London, 2 s: 113, 1899.

[3] W. H. Frost, M. Frobisher, Jr., V. A. Van Volkenburgh and M. Levin, *Am. Jour. Hygiene*, 24: 568–586, 1936.

[4] M. Frobisher, Jr., *Supplement to Am. Jour. Pub. Health*, 30: 28–35, No. 3, 1940.

[5] D. T. Fraser and C. B. Weld, *Trans. Roy. Soc. Canada*, (Sect. V) 20: 343, 1926.

In another experiment with seven-day-old White Leghorn chicks, the following results were obtained: (1) Each of twelve strains of virulent organisms was inoculated subcutaneously in one chick; all twelve chicks died within 24 hours. (2) Twelve chicks, injected intraperitoneally with 200 units of antitoxin two hours previously, were inoculated subcutaneously with the same twelve strains; all twelve chicks remained well for two weeks or longer. (3) Of twelve chicks inoculated with twelve different strains of avirulent *C. diphtheriae,* all but one remained well for two weeks. (4) Of ten chicks inoculated with ten different cultures of diphtheroids, all remained well.

The protocol of a similar experiment with strains other than those mentioned above is shown in Table 1.

TABLE 1

EFFECT OF VARIOUS STRAINS OF CORYNEBACTERIA IN CHICKS

Organism	Result of virulence test in rabbit	Strains	Chicks	Dead	Paralyzed	No visible reaction
C. diphtheriae (with antitoxin)	Positive	10	20	4†	0	16
C. diphtheriae (no antitoxin)	Positive	10	20	19	1	0
C. diphtheriae	Negative	10	20	1*	0	19
C. xerosis	Negative	10	20	1	0	19
C. pseudodiphthericum	Negative	10	20	0	0	20

† The other chick of these pairs, in each instance, survived with no visible illness.
* Only after 5 days; no paralysis observed.

Two White Leghorn chicks were inoculated with each strain. The results are essentially the same as those obtained in the previous experiments.

Altogether, of fifty unprotected chicks injected with 35 different strains of rabbit-virulent *C. diphtheriae,* only one survived, and this after a severe illness, while, of 38 antitoxin-protected chicks injected with the same strains, 33 survived and 5 died, 3 of them from nonspecific causes. Of 36 chicks injected with 26 strains of avirulent *C. diphtheriae,* 34 survived and 2 died. In addition, of fifty chicks receiving thirty strains of diphtheroids, both *C. xerosis* and *C. pseudodiphthericum,* all but one survived with no apparent illness. The possibility of using chicks as test subjects in determining the virulence of cultures of *C. diphtheriae* is thus clearly indicated.

Results obtained with toxic filtrates were equally definite. A preliminary experiment has shown that chicks succumb to *intraperitoneal* injection of as little as 0.5 guinea-pig-M.L.D. of toxin. In Table 2 details are given concerning a group of 48 chicks receiving five different doses of toxin. The data indicate a susceptibility approximating that of 250-gram guinea pigs. In those chicks designated as "ill," paralysis of the wings and legs was a prominent feature. The chicks given doses of toxin larger than 1.0 M.L.D.

TABLE 2

EFFECT OF VARIOUS DOSES OF DIPHTHERIA TOXIN UPON SEVEN-DAY-OLD WHITE LEGHORN CHICKS

Dose of toxin (guinea pig M.L.D.s)	Chicks injected	Fate
3.0	6	6 dead within 26 hours
1.5	12	11 dead within 40 hours 1 very ill for 36 hours, survived, later showed paresis
1.0	13	6 dead within 72 hours 3 " " 5 days 2 ill for 2 days, survived, later showed paresis 2 no evident illness
0.5	13	2 dead within 72 hours 3 " " 5 days 2 moribund and killed on fifth day 1 dead after 6 days 3 ill for 2–3 days, survived, later showed paralysis 2 no evident illness
0.1	6	3 slightly ill up to 96 hours, survived, no damage 3 no evident illness

died promptly. Those receiving less than 1.0 M.L.D. also sometimes died or were ill, but the effect of the toxin was definitely delayed, and paralysis was sometimes not manifest for 36 hours. The contrast between 1.0 M.L.D. and 0.5 M.L.D. in this respect, for example, was quite evident. The reaction to a given dose seemed to be more uniform in the chick than is the case with guinea pigs.

Thus, it has been shown that seven-day-old White Leghorn chicks succumb regularly within 48 hours to subcutaneous injections of 48-hour infusion-broth cultures of strains of *C. diphtheriae* which are virulent for rabbits. The chicks are rarely, if at all, affected by similar infections if protected by intraperitoneal injections of at least 200 units of antitoxin given 2 hours before. Cultures of *C. diphtheriae* and of diphtheroids, previously shown to be avirulent for rabbits, have no perceptible effect on the chickens.

Further, it has been demonstrated that week-old White Leghorn chicks have about the same degree of susceptibility to diphtheria toxin as 250-gram guinea pigs.

These experiments clearly indicate the value of the chick in the study of the diphtheria group of organisms. It is possible that both virulence tests and tests for the potency of diphtheria toxin can be satisfactorily made in week-old chicks. The economic advantages are obvious.[6]

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THE ANTI-TRYPTIC PROPERTIES OF HEPARIN

INVESTIGATIONS of the possible prolongation of insulin action by inhibitors of proteolytic activity[1] have

[6] The author takes pleasure in acknowledging, with appreciation, the technical assistance of Dr. Elizabeth I. Parsons and the advice and encouragement of Dr. Thomas B. Turner.

led to the discovery that heparin is a trypsin inhibitor. This resulted from the examination of many compounds in a search for a simple substance which might retard the activity of specific proteases.

Crystalline trypsin inhibitor is a powerful anti-protease, but the preparation of this compound is time-consuming and the yields comparatively small, hence the search for a substitute. Blood plasma, while a good source of anti-protease activity, is too complex a mixture to permit a carefully controlled study, and the yield of trypsin-inhibitor which may be isolated from plasma[2] is apparently only a small fraction of its total inhibitory power. Similarly, the amino-acid concentrate of Northrop[3] as well as the anti-trypsin of egg white of Balls and Swenson,[4] while comparatively simple to prepare, did not lend themselves easily to further purification in our hands. Heavy metals as well as certain basic dyes are strongly anti-tryptic, but the addition of these substances to the proteases caused the latter to be precipitated from solution, a phenomenon which might easily explain the anti-protease activity.

Many basic dyes are powerful anti-coagulants,[5] and our observation that they may inhibit proteolysis suggested a relationship between the two processes. It was therefore logical to proceed to an investigation of heparin.

Table I presents representative data of the effects of heparin on the hydrolysis of casein by trypsin and chymotrypsin. These proteases were isolated from beef pancreas and recrystallized according to the techniques described by Northrop and Kunitz.[6] The heparin[7] was prepared to contain 2 mg per ml of water. The pH of this solution was 7.30. The casein (Hammarsten) was dissolved in sufficient sodium hydroxide to give a final pH of 7.5 and diluted to a concentration of 6 per cent. The enzyme solutions used contained approximately 0.03 mg of protease nitrogen per ml. The latter were carefully titrated with phosphate buffer to pH 7.30, using a standardized glass electrode system. No inhibition of trypsin is obtained unless the heparin is allowed to remain in contact with the alkaline trypsin solution for about thirty minutes before the two are added to the casein. This fact is particularly significant, since a parallel relationship obtains with trypsin and trypsin inhibitor.[6] Furthermore, the heparin-trypsin addition complex like the inhibitor-trypsin compound may be dissociated by acidifying to pH 3.0 for about 30 minutes to recover all the tryptic activity.

TABLE I

EFFECT OF HEPARIN ON DIGESTION OF CASEIN BY TRYPSIN AND CHYMOTRYPSIN AT 38° C. FORMOL TITRATION OF 3 ML SAMPLES OF DIGESTION MIXTURE EXPRESSED IN ML OF NaOH. (N/10)

Added to 25 cc of 6 per cent. casein after 30-minute contact	Time in minutes						
	15′	30′	60′	120′	180′	300′	480′
1 ml trypsin 1 ml H_2O	.01	.06	.14	.20	.33	.43	.53
1 ml trypsin 1 ml heparin	.00	.00	.04	.07	.13	.20	.29
1 ml chymotrypsin 1 ml H_2O	.05	.11	.18	.25	.31	.39	.48
1 ml chymotrypsin 1 ml heparin	.04	.11	.19	.25	.30	.39	.48

The data in Table I clearly indicate a marked inhibition of trypsin, especially during the first hour of digestion, but no apparent inhibition of chymotrypsin by similar concentrations of heparin. This effect has been checked many times by nephelometric as well as refractometric techniques to eliminate the possibility that the inhibition might be an artifact of the formol titration. Since trypsin catalyzes the clotting of recalcified oxalated plasma, and chymotrypsin is comparatively inert in this respect, the anti-tryptic propensity of heparin acquires additional significance. Preliminary experiments have indicated that in a given sample of plasma, added trypsin and heparin are mutually antagonistic and that clotting will not occur unless the amount of trypsin added is more than enough to neutralize the effect of heparin. Ferguson[8] has postulated the presence in blood of a "thromboplastic enzyme" which hypothesis is supported by the above observations.

Alterations in the anti-tryptic titre of plasma have been unexplained phenomena for several decades. Having the information that heparin is anti-tryptic, it may now be possible to correlate certain increases in blood anti-trypsin with increases in heparin. For example, Jaques and Waters[9] have recently shown that heparin is greatly increased in the blood of dogs in peptone shock, whereas in 1915 Jobling, Peterson and Eggstein[10] showed that peptone shock caused an increase in blood anti-trypsin. Further research on the amounts of heparin in various physiological states may present similar correlations.

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[1] M. K. Horwitt, *Am. Jour. Physiol. (Proceedings)*, 129: 89, 1940.

[2] A. Schmitz, *Zeit. physiol. chem.*, 255: 234, 1938.

[3] J. H. Northrop, *Jour. Gen. Physiol.*, 4: 227, 1921.

[4] A. K. Balls and T. L. Swenson, *Jour. Biol. Chem.*, 104: 409, 1934.

[5] H. Hermann, *Skand. Arch. Physiol.*, 76: 125, 1937.

[6] J. H. Northrop, "Crystalline Enzymes," Columbia University Press, 1939.

[7] Obtained from Connaught Laboratories, Toronto. Activity 110 units per mg.

[8] J. H. Ferguson and B. N. Erickson, *Am. Jour. Physiol.*, 126: 661, 1939.

[9] L. B. Jaques and E. T. Waters, *Am. Jour. Physiol. (Proceedings)*, 129: 93, 1940.

[10] J. W. Jobling, W. Peterson and A. A. Eggstein, *Jour. Exp. Med.*, 22: 129, 1915.

GLYCINE—AN ESSENTIAL FACTOR FOR THE GROWTH OF BACTERIOPHAGE[1]

BACTERIOPHAGE does not grow in bacterial cells suspended in water. We have found that bacteriophage will multiply in bacterial cells suspended in dilute solutions of pure glycine. The increases are from 8- to 10-fold during 3-hour incubation at 37° C. The bacteria do not multiply under these conditions in a 6.5-hour observation period.

The details of a typical experiment follow: Bacterial cells (*Es. coli*) in nutrient broth were infected with phage,[2] centrifuged down with their attached phage and resuspended in distilled water. 0.1 cc samples of this suspension were added to 0.9 cc samples of the following solutions: glycine (200 mg per cent.), nutrient broth, synthetic medium,[3] distilled water, phosphate buffer (pH 7.0) and 0.9 per cent. sodium chloride. In the nutrient broth and synthetic medium controls, phage growth (measured by plaque count) was rapid as we have described in a previous communication.[2] In the distilled water, buffer and saline controls there was no phage growth. In fact, in the water and in the saline the phage decreased. This we attribute to the death of phage-infected bacteria. In the glycine solution the phage increased, after a latent period of more than 35 minutes, to 6 times its original value at 100 minutes and 8 times the original value at 150 minutes.

The following substances were negative in this respect: asparagine, glucose, glucose in phosphate buffer, arginine, nucleic acid, alanine and diglycylglycine. The synthetic medium in which glucose and asparagine were the only organic constituents permitted phage growth, and yet these constituents separately did not support the growth of the virus.

Our sample of nucleic acid, which was probably impure, permitted the bacteria to grow slowly without accompanying phage growth. Evidently the processes within the cell which permit it to multiply are not identical with those required for phage growth, and *vice versa*.

The conditions under which the above experiments were carried out exclude the possibility of a failure of the virus to come in contact with its substrate in the bacterial cell. The failure of phage growth in distilled water and other pure solutions (*i.e.*, as distinguished from broth) is to be ascribed to the necessity of specific substrates for the growth of the phage.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

GLASS TUBES FOR REARING PHLEBOTOMUS AND OTHER INSECTS[1]

IN rearing Peruvian Phlebotomus sandflies in connection with studies on Carrión's disease, we have devised a new type of porous breeding-vessel which is also of value in the handling, transportation and rearing of other insects.

All methods of rearing sandflies in the laboratory involve keeping the engorged females at a high degree of humidity in a vessel with a moist inner surface on which the eggs may be laid. The commonest type of breeding-vessel is a small porous earthenware pot. This serves very well for mass rearing but is not convenient when large numbers of sandflies are to be handled separately. Adler and Theodor[2] secured oviposition by keeping females in glass tubes temporarily cemented to porous stone. We have endeavored to devise units complete in themselves which would combine the convenience of the glass tube with the essential functions of the porous breeding-pot, a result finally achieved by simply filling one end of the tube with plaster of Paris. Tubing with a bore of 8–9 mm is satisfactory for most sandflies, though a large species, such as *Phlebotomus peruensis*, requires larger tubing. A convenient length is eight centimeters. The plaster should extend into the tube for 10–12 mm. The open end is stoppered with cotton. These rearing-tubes may be made in quantity by standing bundles of cut tubing in dishes of freshly mixed plaster.

Before the tubes are used the plaster is moistened by contact with wet cotton. When containing sandflies they are stored, plaster end down, in moist earthen pots or in pans with a thick bottom layer of plaster. The highest degree of moisture short of condensation on the glass walls is desired. Plaster with the correct moisture content has a characteristic appearance which the operator soon learns to recognize. The eggs are laid on the plaster or on the glass just above it. The original tube may be maintained as a breeding-vessel for the larvae, but since there is usually not room enough for the progeny of one female, it is better to transfer the eggs to the standard breeding-pot. The eggs are not injured by immersion in water and transfer is easily made with a pipette and water.

[1] Supported by a grant-in-aid from Mrs. Seeley W. Mudd.

[2] E. L. Ellis and Max Delbrück, *Jour. Gen. Physiol.*, 22: 365, 1939.

[3] For the composition of this medium, see Max Delbrück, *Jour. Gen. Physiol.*, 23: 643, 1940.

[1] Contribution from Departamento de Entomología Médica, Instituto Nacional de Higiene y Salud Pública, Lima, and Department of Comparative Pathology and Tropical Medicine, Harvard Medical School, Boston.

[2] S. Adler and O. Theodor, *Proc. Roy. Soc. London*, Series B, 116: 505–515, 1935.

Adult sandflies of either sex live as long in the plaster-plug tubes as in the standard breeding-pots, and we believe that the average yield of eggs is greater. The larvae, however, get along better and with less attention in the earthen pots. Our routine rearing technique is therefore a combination of the two methods. The tubes may be autoclaved and used a number of times, but in practice it is more satisfactory to use only fresh plaster.

FIG. 1.

In addition to serving as breeding-vessels for Phlebotomus, the plaster-plug tubes have proved useful in a number of other ways. They permit any desired degree of moisture and thus provide an excellent container for the transportation and temporary storage of living insects. They are in routine use for catching sandflies and other insects in the verruga zone and transporting them alive to the laboratory in Lima. They may prove useful in shipping live insects considerable distances. With these tubes we have secured, through the cooperation of a physician whom we instructed in their use, living sandflies and eggs from a region several days' journey from Lima.

Tubes of this type can doubtless be adapted to the rearing of various other insects. Though we have not had occasion to try them out extensively, we have used them successfully in rearing several species of fleas.

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THE ADMINISTRATION OF DRUGS TO RATS

IT is often necessary to give experimental animals quantitative doses by mouth, and frequently the material given is distasteful. Even those with much experience in giving a stomach tube to rats occasionally kill a valuable animal and at best the process is time consuming and unpleasant. A substitute technique has been found to be successful. Dissolve or suspend the material in a sucrose solution and measure it from a needleless tuberculin syringe into a rat's mouth. All rats like sugar and will take anything that can be made to taste sweet. Bile salts and other bitter material is consumed better in suspension than solution. It is recommended that two or three practice periods precede the experimental feeding. If the rat lies on its back with head slightly raised, there is no danger of spilling if the stream from the syringe is adjusted to the rate at which the rat laps. Most rats will try to turn over until this position is conditioned to the pleasure of drinking the sugar water.

This method has been used on several hundred rat including many suffering from complete anorexia due to adrenalectomy or severe diseased conditions. Vitamins, ethynil testosterone and other hormones, sulfapyridine and many other substances have been given. The method has failed only in the administration of such irritants as CCl_4, where the trauma to the tissues of the mouth outweighs the appeal to the "sweet tooth."

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KEEP BOTTLE-TOPS FREE FROM DUST

LABORATORY bottles invariably gather dust. After pouring from them fluid remains on the lip and around the stopper, to dry out, effloresce or otherwise create and attract dust. Cleaning them daily is a time-consuming labor, with danger of contamination from the usual wet cleaning-cloth. Such dirt and contamination may affect laboratory procedures adversely, particularly in the case of preparations for microscopic study.

A simple and effective means of keeping bottle-tops clean is to cover each with an inverted paper drinking-cup. These cups may be had in various sizes to fit different types of bottles; they are inexpensive and may be discarded when soiled.

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